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JULY-AUGUST, 1929
VOL. VI Nos. 7 & 8

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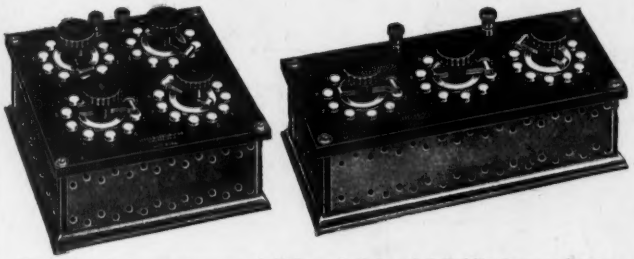

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Atelier Victoria

EMIL FISCHER

EDITOR'S OUTLOOK

"THE boy is too stupid for a business career; he had better study." That is what the father of Hermann Emil Fischer said, when, after having put the seventeen-year old boy in the lumber concern of a close relative, he found him unhappy and addicted to trying chemical experiments in an empty room of the establishment. And so, in 1871, we find Emil at Bonn studying chemistry under Kekulé.

Emil Fischer

But Bonn and Kekulé did not satisfy him. He went to Strassburg in 1872 and there found Baeyer who apparently completely won his admiration and who exercised an important influence over his life. He received his doctor's degree at Strassburg in 1873. In 1875 his research was rewarded by his discovery of phenylhydrazine. Baeyer was now called to Munich, and Fischer followed him there, continuing his work in the laboratory.

His rise to prominence was destined to be rapid. When, in 1885, he went to Würzburg to fill the professorship offered him there he was already considered one of the four or five leading chemists of Germany.

Fischer will probably always be remembered for his work on sugars. It was while he was at Würzburg that he found out, among other things, how to synthesize them and to prepare new ones artificially. This work has helped toward an elucidation of the way in which the plant forms carbohydrates.

We may look back on Fischer's progress up to this point and say that there is little reason why he should not have succeeded, especially with the fine equipment at his command. But we come to a period of his life when his laboratory equipment is very poor and his additions to organic chemistry are increasingly brilliant. In 1892 he was called to Berlin University—a signal distinction. He came on the condition that a new laboratory be built. But the Berlin authorities were seven years in fulfilling their promise, owing to the financial status of the university. Yet in 1892 Fischer prepared several artificial glucosides and by 1894 he had developed the enzymic methods of splitting sugars.

Fischer had received one of the highest honors that his country could pay him—election to a professorship at the Berlin University. In 1902 came international distinction in the form of the Nobel prize, which was granted for his work on sugars and purines.

Even more important than this work was Fischer's research on proteins. Indeed the unraveling of this problem has had a far-reaching influence on modern chemistry. He and his students synthesized several of the nineteen amino acids and built them up into proteins. Most celebrated of all was his preparation, from fifteen glycine and four leucine mole-

cules, of a polypeptide which in many ways resembles the natural proteins.

The World War brought a great deal of sorrow into Emil Fischer's life. We know that he was intensely pro-German. According to Harrow: "The magnitude of Germany's *débacle* would have crushed a spirit less proud than *Geheimer-Regierungsrat* Fischer." And what it meant to him is pictured for us by Hoesch, his biographer: "his country vanquished, his science threatened, all those things at which he had toiled without stint, menaced." It is pleasant to remember of him in this period of turmoil that he was among the few who protested against Ramsay's name being dropped as an honorary member of the *Chemischen Gesellschaft*. The honor was for Ramsay the scientist, not Ramsay the Englishman, he declared.

He did not long survive his country's defeat. After a period of rapidly failing health, originating perhaps in poisoning from the vapors of phenylhydrazine, he suffered a severe intestinal attack from which he died within a few days.

In conclusion, feeling our inability to estimate adequately the worth of this eminent organic chemist, we should like to quote Harrow's opinion:

"With an imagination tempered only by a splendid scientific training, an originality of mind which made a lasting impress upon every piece of work with which he was associated, and a rare skill in devising apparatus, he, first by his own labors, and later, as director-general of an army of aspiring students, gradually unfolded the mysteries that had enshrined the most complex chemical substances known to man. Like all great contributions, his has added not only to our chemical knowledge, but has shed a flood of light on cognate sciences, such as botany, zoölogy, and physiology." And again: "Fischer's death is an irreparable loss to science. He is so much of our generation that one hesitates to use superlatives, but one is sorely tempted to speak of him as the greatest organic chemist of all times."

It is through the kindness of one of our foreign editors, Professor K. Freudenberg of the University of Heidelberg, that we have collected photographs of the German Nobel prize winners in both chemistry and physics. The photograph of Fischer, reproduced as a frontispiece in this issue, is the first of this collection that we have presented to our readers.

The Prize Essays

IN CONTINUATION of an annual custom the JOURNAL presents in this number the college essays which won first prizes in the American Chemical Society essay contest for the scholastic year, 1928–29.

Mr. and Mrs. Francis P. Garvan have generously continued the grant which makes these contests possible, and the program for the coming year is already nearly

completed. The Committee on Prize Essays has again made some alterations in the rules of the contest with a view toward furthering the aims of the project and improving the quality of the contributions submitted. Most significant of these is the decision to draft a number of specific titles under each of the six general titles which have hitherto been offered the contestants. It was felt that this device would have the effect of preventing some students from attempting to cover a broader field than could be adequately treated in the amount of space permitted them. Proper selection of specific topics should also discourage, to a certain extent, a rather too-prevalent tendency to model essays after past prize-winning contributions. Furthermore, the judges are thus afforded an opportunity to familiarize themselves more thoroughly with the literature on relevant topics and hence to prepare themselves to evaluate the subject matter of the essays more competently.

The committee is also executing a project which has been some time in contemplation and in process of preparation. This is the publication of a small pamphlet in which are outlined the plans adopted at a number of colleges and universities for the promotion of the essay contest. In response to inquiries sent out, about ninety-nine replies have been received and there is a wide variation in the programs described. In a few cases the replies are so brief that it is difficult to classify the procedure followed. Neglecting these, some notion of the general trend may be conveyed by the following analysis.

In something over thirty per cent of the institutions reporting, no credit in chemistry is given for the writing of the essays. The contest is encouraged as an extra-curricular activity, and in most cases the students receive the benefit of assistance and criticism from their instructors. In a few instances only the better students are encouraged or permitted to participate.

In about the same proportion of institutions the essay contest is a regular part of the elementary chemistry course and is credited as such. The best essays produced are entered in the national contest.

Approximately fifteen per cent of the institutions reporting do not require the writing of essays but do accept essays in lieu of other work which is required. Reports on outside reading, term papers on chemical subjects, and minor quizzes are examples of work for which the essays may be substituted.

About one-fifth of the chemistry departments listed neither require the essay nor accept it as an optional substitute for other work, but do award extra credit or an increase in term grade for good work in that field.

In most institutions there is coöperation between the chemistry and English departments, at least to the extent that the English department

criticizes the essays from a literary standpoint. English departments in about forty-five per cent of the institutions reporting give extra credit for the prize essays or accept them in lieu of major themes or other composition work. One department lists the prize essay topics as required theme subjects.

Probably there is no one best program which would seem equally desirable everywhere. Perhaps some instructors and institutions will always desire to encourage participation in the essay contest and to aid students in preparing essays but will prefer, nevertheless, that the contest maintain an extra-curricular status. On the other hand, it is certain that many instructors are finding the essay contest valuable as a basis for supplementary or integral course work. We believe that where general conditions and the inclination of the instructors make it feasible, the latter is the better program. It is an arrangement which has already spread widely, and will, we trust, continue to do so.

NEW DATING

In compliance with the decision of the Executive Committee of the Division of Chemical Education at the Columbus meeting, the JOURNAL is now bringing its dating into accord with the usual practice among monthly publications. That is to say that, although the JOURNAL will continue to appear between the fifteenth and the twentieth of each month, the numbers will bear the dates of the respective succeeding months rather than those of the months in which they actually appear. Since it seemed undesirable, for a number of reasons, to attempt the production of two complete numbers within any one month, the expedient of publishing one doubly-dated number has been adopted. Hence, the present issue is the July-August number for 1929. Twelve JOURNALS will appear during the year as heretofore, the only significant difference being that the bound volumes for 1929 will contain only eleven complete JOURNALS, since the number mailed in December will bear the date, January, 1930. The business manager, Mr. Wm. W. Buffum, has arranged that advertisers and subscribers will be in no wise affected by the change—a year's contract or subscription is good for twelve JOURNALS, regardless of dating.

THE NATURAL CHEMICAL RESOURCES OF AUSTRALIA PLANT PRODUCTS. PART I

A. R. PENFOLD, CURATOR AND ECONOMIC CHEMIST, SYDNEY TECHNOLOGICAL MUSEUM, SYDNEY, AUSTRALIA

We, in Australia, are inclined to hide our light under a bushel, having been loath in the past to bring under the notice of the world in general our interesting and fascinating natural resources, particularly in regard to the economics of our native plants. Steady work has been in progress for many years, but beyond publication in the scientific journals, very little has been written on the subject with the exception of popular newspaper articles.

There are a few Australian essential oils known to the commercial markets of the world. I refer particularly to the *Eucalypts*. I have been surprised at the lack of knowledge, despite the circulation and abstraction of scientific papers, regarding the composition and properties of these comparatively very common commercial oils. Correspondence from American friends has revealed this defect in a most marked manner and I hope that the information set forth in this article will remedy it and, moreover, be the means of creating interest in the commercial utilization and value of these natural products. Australia possesses a most unique flora, peculiarly its own, and its investigation by a limited number of workers has revealed a surprisingly fruitful field for harvesting by the chemists. To those chemists who delight in unraveling the secrets of the chemical nature of plant products, the Australian bush makes an irresistible appeal. A walk through the scrub or the mere brushing of one's way through the luxuriant vegetation growing alongside the water courses and winding creeks, soon reveals the wealth of exquisite essential oils which abound therein. This exhilarating experience may befall the keen observer in country but a few miles distant from the city of Sydney.

Although many Australian plants have been examined for alkaloids, glucosides, saponins, etc., those yielding essential oils have naturally attracted and receive the greatest attention. As it is a subject upon which I can write with considerable first-hand knowledge, it is my intention to treat only of these plant constituents in this contribution.

Plants containing essential oils attracted interest practically from the time of the foundation of the Colony of New South Wales in 1788, the commercial value of many being soon revealed. One of the best-known and most widely distributed genus of trees is that of *Eucalyptus*, the three hundred odd species of which form approximately 75% of the vegetation of Australia. The name is derived from the two Greek words *eu*, well, and *kalypto*, I cover, in reference to the lid or *operculum* which covers the flowers and is thrown off. These trees are known vernacularly to most

Australians by the title of "gum trees" which name, however, is a misnomer, as the exudation is of the nature of an astringent tannin, called a *kino* and is not a gum.

One of the first articles of export from Australia was the essential oil of *Eucalyptus piperita*, commonly known as the Sydney peppermint which grew plentifully where the city of Sydney, with a population of $1^1/_4$ millions, now stands. It was distilled in 1788 by Dr. White, surgeon to the First Fleet, and was so named by him on account of his observation that it bore a strong resemblance in medicinal properties to English peppermint oil. It is of special interest to note that although the pharmacopeias of the United States and other countries demand a minimum content of 70% cineol, the medicinal properties of eucalyptus oil were founded upon those oils which did not contain this constituent. Pharmacopeias still refer to commercial *Eucalyptus* oils as being derived from *Eucalyptus globulus*, and although large quantities from this species were exported from Tasmania many years ago, such is not now the case. The reason is not far to seek. *Eucalyptus globulus* yields only 0.75% of oil as against *Eucalyptus polybractea* 2% and *Eucalyptus Australiana* $2^1/_2$ to 4%, the last-named oils being much superior in quality.

A good deal of ignorance apparently exists, particularly in America, regarding the various kinds of commercial Eucalyptus oils and the species from which they are derived.

The following table will clarify the position and I hope assist in removing the prevailing erroneous impressions:

Botanical name	Common name	State of commonwealth	Principal constituent	Type of oil
E. polybractea	Blue mallee	Victoria and N. S. Wales	80 to 85% cineol	Medicinal oil
E. Australiana	Black peppermint	N. S. Wales	60 to 70% cineol	Medicinal oil
E. elaeophora	Apple jack	Victoria	70 to 75% cineol	Medicinal oil
E. sideroxylon	Iron bark	Victoria	70 to 75% cineol	Medicinal oil
E. dives	Broad leaf peppermint	N. S. Wales and Victoria	50% piperitone 40% phellandrene	Industrial oil
E. phellandra	Narrow leaf peppermint	N. S. Wales and Victoria	35% cineol 40% phellandrene	Industrial oil
E. citriodora	Lemon-scented gum	Queensland	90/95% citronellal	Perfumery oil
E. Macarthuri	Camden woolly butt	N. S. Wales and Victoria	60% geranyl acetate	Perfumery oil

One species is deserving of special mention on account of the prominent part it has played in the establishment and development of the synthetic thymol and menthol industry. I refer to *Eucalyptus dives*, the broad leaf peppermint of the mountain ranges of New South Wales and Victoria, which yields an essential oil to the extent of 40 lb. per thousand lb. weight of leaves and terminal branchlets. It contains a constituent of faint

FIELD OF EUCALYPTUS TREES AT MONGARLOWE, NEW SOUTH WALES

Of the essential oil-containing plants of Australia, the Eucalyptus is the most widely distributed, the three hundred odd species forming approximately 75% of the vegetation of the country. The chemical nature of the wealth of these exquisite oils should prove a fascinating and fertile field for investigation. The common commercial Eucalyptus oils are today being used chiefly for medicinal, perfumery, and industrial purposes.

peppermint odor to the extent of 50% known as piperitone or Δ_1-menthenone-3. On oxidation it is easily converted into thymol and is readily reduced, on the other hand, to menthone and menthol. The areas of this species are of very great extent, but great quantities of leaves are required to meet the increasing export demands for this oil. The species grows on comparatively poor soil, generally unfit for agricultural and grazing purposes. The trees are cut within two feet of the ground when they readily give forth new growth known vernacularly as "sucker growth." This growth is of a particularly foliacious nature and according to the rainfall and other conditions is ready for cutting again in about 2 years' time. The trees improve considerably with repeated cutting and this reproductive property is one of its characteristic features. Over 20,000,000 lb. weight of leaves are cut annually.

One of the most important of botanico-chemical observations has recently been brought to light by the chemists of the Sydney Technological Museum in connection with this species. Extensive field observations, together with analyses of many distillations of essential oils, have revealed a number of varieties or forms of *Eucalyptus dives* not determinable as yet on morphological premises by botanists.

The following table affords striking evidence of these observations:

EUCALYPTUS DIVES

	Type	Var. "A"	Var. "B"	Var. "C"
Percentage yield of oil	2.5 to 4%	1.5 to 4%	3 to 4%	2 to 3%
Specific gravity	0.892–0.907	0.863–0.877	0.906–0.915	0.916–0.924
Optical rotation	−58° to −80°	−44° to −70°	−13° to −28°	±1° to 8°
Refractive index	1.4788–1.4810	1.4750–1.4792	1.4669–1.4711	1.4635–1.4742
Solubility in 70% alcohol	Insoluble in 10 vols. to soluble in 1.2 vols.	Insoluble in 10 vols.	Soluble in 1.1 to 1.3 vols.	Soluble in 1.2 to 1.4 vols.
Piperitone	46 to 53%	5%	10 to 20%	under 5%
Cineol	.....	.....	25 to 45%	60–75%
Phellandrene	About 40%	About 75–80%	Present in quantity	Absent

There is no doubt at all regarding the diversity of chemical composition as revealed by this table, one kind of oil being of value for industrial purposes while another is the very antithesis in producing one of the most valuable of oils for medicinal purposes. The writer has examined many areas of these trees and is able to speak from first-hand knowledge that it is impossible to distinguish these trees except by crushing the leaves in the hands and determining the particular form by the odors evolved. One can become quite skilled in the detection and separation of "good" and "bad" areas of country according to the type of oil required. All com-

CRUDE FIELD STILLS IN OPERATION AT SUNNYCORNER, NEW SOUTH WALES
Battery of four distilling the leaves of *Eucalyptus dives*.

mercial fields whether worked for either the type or variety *C* contain approximately 5% or so of forms *A* and *B*. In variety *C* we have an excellent source of medicinal oil which together with *E. Australiana* is probably one of the best oils extant for pharmaceutical purposes. The cineol content is from 60 to 70%, the other constituents being pinene, terpineol and its esters, with a trace of citral which gives it a refreshing aroma. The oil is practically water white as it issues from the crude stills, and being extremely low in volatile aldehydes does not require rectification.

An illustration is furnished showing in actual operation a series of crude stills used in the winning of Eucalyptus oils together with one depicting the nature of the trees and country in the hope that they will be of considerable interest to American readers. They represent typical Australian bush scenes.

It may be of some interest to mention that the so-called industrial oils like *Eucalyptus phellandra, dives*, etc., are used extensively in Australia for the manufacture of cheap disinfectants for picture shows, theaters, etc., by incorporation in a soap solution. These preparations are rapidly ousting the coal-tar preparations from the market. The germicidal values of the various pure constituents have been found to possess high Rideal-Walker coefficient varying from 5 to 22.

Before concluding my remarks on Eucalyptus oils I cannot allow the opportunity to pass without criticizing the present policy of pharmacopeias, more especially the United States Pharmacopeia, of maintaining a high standard of cineol content with a pronounced tendency to be overparticular in limiting the amount of phellandrene. I am unacquainted with any evidence which shows the medicinal value of Eucalyptus oils to be due to cineol. On the other hand, Eucalyptus oil established its reputation for medicinal purposes on an oil practically free of cineol but rich in phellandrene and piperitone.

I believe the time is rapidly approaching when this phase of the subject should be investigated.

Other Essential Oil-Yielding Plants

As previously mentioned, Australia is especially rich in essential oil-yielding plants, but their commercial exploitation outside of the Eucalypts depends upon extensive cultivation in order to meet the demand that must eventually arise for those richest in valuable odoriferous constituents. It would occupy much more space than is available, were I to treat of them individually. I will therefore content myself with a selection of the more important ones.

Leptospermum citratum.—This is a tall shrub belonging to the natural order *Myrtaceæ* yielding from 1–1½% of a pale yellow essential oil containing approximately 95% of aldehydes (50% citral and 45% citronellal).

TWO-YEAR OLD HEDGE, JUST PRIOR TO TRIMMING, OF *Leptospermum citratum*, PENNANT HILLS, NEW SOUTH WALES

This shrub yields a pale yellow oil consisting of about equal proportions of citral and citronellal, the quality of these products comparing favorably with those derived from other sources. An extensive study of the soil and moisture conditions necessary for the growth of this species has been carried out, for the commercial exploitation of any plant depends upon its ease of cultivation.

The plant is found at Copmanhurst, New South Wales, and on the Macpherson Range, Queensland, but only to a limited extent. It is remarkable for the ease with which it can be cultivated and experimental plantations have now been established in Queensland and Western Australia. The citral prepared from this oil is at least equal to that obtained from *Backhousia citriodora*, the famous Queensland tree which yields an oil consisting almost entirely of that aldehyde. *Leptospermum citratum* has been tested out in practically all types of soil and has given good results. It thrives best in a situation having access to a moderate amount of moisture. The illustration on page 1201 shows a hedge of this shrub two years old just prior to trimming.

The interest attached to the plants to be discussed is the variation in chemical composition existing between closely allied plants of a genus. Take, for instance, the series of the beautiful pinnate leaf *Boronias*, pretty shrubs with pink flowers belonging to the natural order *Rutaceæ*. These plants are very difficult of botanical differentiation, yet a study of the essential oils reveals a fascinating variation in chemical constituents each of which occurs in abundance in the respective species. The results set out in tabular form hereunder present the matter in a very striking manner:

	Boronia pinnata	*Boronia muelleri*	*Boronia thujona*	*Boronia safrolifera*
Yield of oil	0.02–0.1%	0.38–0.57%	0.5–0.8%	1.45%
Specific gravity	0.8784–0.8917	1.0197–1.0265	0.9121–0.9152	1.04
Optical rotation	−4.7° to −15.3°	+1.5° to +3.8°	+12° to −56.5°	+3.8°
Refractive index	1.4762–1.4825	1.5125–1.5150	1.4526–1.4543	1.5180
Principal constituents	limonene, *d*-α-pinene, sesquiterpene	elemicin (75–80%), *d*-α-pinene	α-and β-thujone	safrol (70–75%) methyl eugenol, etc.

Another similar example is the occurrence of a shrub, which abounds in the Northern Rivers District of New South Wales and parts of Queensland, known as *Leptospermum liversidgei*. These results are of considerable economic importance as the investigation of the essential oils has brought to light the following forms of this shrub which are quite indistinguishable from one another even in the field and only by crushing the leaves between the hands and observing the different odors can their separation be effected without chemical examination of the essential oil.

(*a*) One yielding an oil to the extent of 0.25 to 0.3% containing 35 to 50% citral.

(*b*) A form yielding an oil to the extent of 0.55% containing 70 to 80% citronellal.

(*c*) A form yielding 0.6 to 0.8% of an oil containing 70 to 80% citral.

TREE OF *Melaleuca linariifolia*, NEW SOUTH WALES

The essential oil derived from this tree, which is one of a number of trees and shrubs known collectively as Tea Trees, is about to be placed upon the markets of the world.

A series of essential oils obtained from four species of trees and shrubs belonging to the typical Australian genus *Backhousia*, were found to contain major constituents of the most diverse chemical composition. The results are best summarized for comparative purposes in the following table:

BACKHOUSIA SPECIES

	Backhousia citriodora	*Backhousia myrtifolia*	*Backhousia angustifolia*	*Backhousia sciadophora*
Yield of oil	1%	0.5%	0.75%	0.30%
Principal component	citral (98%)	elemicin (75–80%)	new phenol (75%)	*d*-α-pinene (90%)
Formula	$C_{10}H_{16}O$	$C_{11}H_{12}O_3$	$C_{10}H_{14}O_3$	$C_{10}H_{16}$
Type	aldehyde	phenol-ether	phenol	terpene
Odor	lemon	myrtle	drug-like	turpentine

The investigations conducted up to the present time direct attention to the great importance of chemistry in the study of plants, more particularly as an aid to the differentiation of closely allied species and forms. A very good example was a study of two small shrubs belonging to the genus *Homoranthus*. Allan Cunningham, when establishing the genus in 1840, differentiated the two species *Homoranthus virgatus* and *H. flavescens*. Later botanists such as Bentham and Mueller united the two species under *H. virgatus*. Many years later, Mr. E. Cheel of the National Herbarium, Sydney, again separated them on morphological grounds considering them to be quite distinct species. The writer examined the essential oils and the results confirm in a very remarkable manner the individuality of the two species as shown by the following table:

	H. virgatus	*H. flavescens*
Yield of oil	0.35–1%	0.35–1%
Specific gravity	0.8660 to 0.8927	0.820 to 0.843
Optical rotation	+18 to +28	+1.5
Refractive index	1.4743 to 1.4818	1.4836 to 1.4873
Principal constituent	80% *d*-α-pinene	80% ocimene

The two terpenes, pinene and ocimene, possess entirely different properties and chemical constitution and, so far as is known, the latter, being an open chain compound, bears no relation at all to pinene.

Tea Trees.—In some parts of Australia vast areas of country are thickly covered with trees and shrubs belonging to such genera as *Melaleuca, Leptospermum, kunzea*, etc., and are known collectively as Tea Trees. An illustration on page 1203 shows a typical tree of *Melaleuca linariifolia*. Very large areas in the Northern Rivers District of New South Wales are covered with a particular species, *Melaleuca alternifolia*. It is of special interest at the present juncture as the essential oil is about to be placed upon the markets of the world. The chemical composition is particularly

interesting in as much as it reveals the wealth of interesting constituents which abound in the essential oils of Australian plants, *viz.*: *d*-α-pinene, α- and γ-terpinene, cymene, cineol, terpineol-4, cadinene, etc. The closely allied species *M. linariifolia* is essentially the southern form of *M. alternifolia* and yields an essential oil similar in chemical composition.

I trust this short account concerning Australia's chemical wealth in the field of its native flora will appeal to a wide circle of readers and thus create the necessary incentive for future chapters.

Fourteen Americans Elected to National Science Academy. Fourteen Americans and five foreigners were honored by the National Academy of Sciences recently at the concluding session of their annual spring meeting, either by election to membership or to the foreign associateship.

Prof. Arnold Sommerfeld, famous physicist of Munich, Germany, who attended the scientific sessions of the meeting as a guest, was one of the newly elected foreign associates. The others included Richard Hertwig, zoölogist, also of the University of Munich; C. de la Vallée-Poussin, professor of analytical mechanics at the University of Louvain; Willem de Sitter, of the Observatory of Leiden, Holland; Frederick Orpen Bower, British botanist, formerly Regius Professor of Botany at the University of Glasgow.

The new members of the academy are Dr. Roger Adams, professor of organic chemistry at the University of Illinois; Irving W. Bailey, associate professor of botany, Bussey Institution, Boston; Dr. A. F. Blakeslee, botanist at the Carnegie Institution's station for experimental evolution at Cold Spring Harbor, N. Y.; Dr. James B. Conant, associate professor of chemistry, Harvard University; Dr. Bergen Davis, professor of physics at Columbia University; Dr. C. J. Davisson, physicist at the Bell Telephone Laboratories, New York, whose recent work in proving the wave nature of electrons has been hailed as one of the most important advances in physics; Dr. Joel H. Hildebrand, professor of chemistry at the University of California, Berkeley; William Hovgaard, Danish-born professor of naval design at the Massachusetts Institute of Technology; Dr. Albert W. Hull, research physicist at the General Electric Company's Research Laboratory at Schenectady, N. Y.; Frank Leverett, geologist of the U. S. Geological Survey and lecturer in glacial geology at the University of Michigan, Ann Arbor; Dr. Paul W. Merrill, astronomer at the Mt. Wilson Observatory, Pasadena, Calif.; Dr. David H. Tennent, zoölogist at Bryn Mawr College, Pennsylvania; Dr. George H. Whipple, dean of the School of Medicine and Dentistry and professor of pathology at the University of Rochester, N. Y.; and Dr. Clark Wissler, curator of ethnology at the American Museum of Natural History, New York, and professor of anthropology in the Institute of Psychology at Yale.—*Science Service*

A CORRECTION

In the article on "Biophysical Chemistry. Part I," by V. Cofman, on page 860 of the May issue, Figures 3 and 4 should be transposed.

RHEOLOGY. II. THE NATURE OF PLASTIC FLOW AND ITS RELATION TO FLUID FLOW

EUGENE C. BINGHAM, LAFAYETTE COLLEGE, EASTON, PENNSYLVANIA

It is difficult for one to imagine himself back in history a mere hundred years when the science of electricity was still non-existent and Dr. G. S. Ohm was attempting to overcome the vagueness in the conceptions in regard to the intensity and capacity factors of electricity, clear now to every school boy. Unfortunately, the properties of flow are still vague although Robert Hooke announced his law of elastic deformation two-hundred and fifty years ago and Newton gave the fundamental law of fluid flow, later demonstrated by Poiseuille, some two hundred years ago. Thus, the terms consistency, plasticity, tackiness, shortness, hardness, etc., no one understands.

There are no properties of colloids which are so characteristic as the properties of flow. It was the prophetic insight of Thomas Graham which caused him to speak of "the viscometer as a colloidoscope." The term "prophetic" is used advisedly because, in the time of Thomas Graham, the viscometer as a colloidoscope was not very satisfactory, yet one can now see clearly enough to go beyond Graham and declare that *the plastometer is a colloidometer*. The plastometer is more than a detector of the presence of colloids, it promises to give the most valuable control of colloidal properties. The term plastometer instead of viscometer is preferred because colloids are plastic, not viscous, and obey the laws of plastic flow but not the laws of viscous flow; and the attempt to ignore this difference has repeatedly led to misfortune. For example, paint and plaster and clay flow easily under brush, trowel, or shaping tool, but there is nothing in the laws of viscous flow which permits these materials to remain in position in opposition to gravity after the original deformation of the craftsman. On the contrary, the laws of viscous flow if applied to paint, clay, butter, and plaster would expect them to flow continually under any shearing stress just as pitch does. We therefore conclude that it is the plastometer which is the colloidoscope and to the understanding of the laws of plastic flow we may safely look for the quantitative measurement of colloidal properties.

We have seen* that the simple law of viscous flow of Newton is

$$v = \varphi F r \qquad (1)$$

The simplest assumption which we can make to account for the phenomena of plastic flow would seem to be that a certain definite shearing stress is required before the material begins to yield and then the flow is proportional to the excess of shearing stress, or,

$$v = \mu (F - f) r \qquad (2)$$

* See Part I, THIS JOURNAL, 6, 1113 (June, 1929).

when μ is called the mobility and f the yield value. The mobility becomes the fluidity as the yield value vanishes. It is the existence of this definite yield value that makes the distinction between a solid and a liquid. This is a pure assumption and must be tested out for all sorts of materials and conditions of flow. And just as equation (1) is subject to various correc-

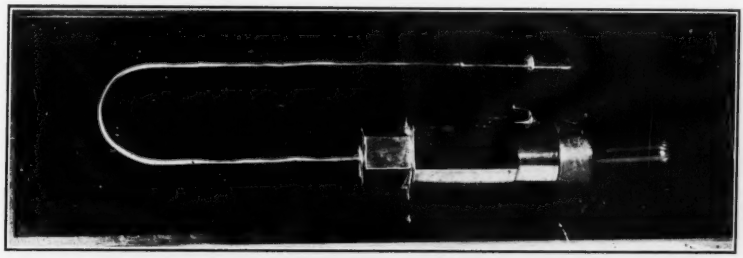


FIGURE 4.—THE FIRST FORM OF PLASTOMETER

tion terms, which are not entirely understood even yet, so equation (2) is subject to corrections for various factors such as seepage and slippage. But it has been found to hold within certain limits for many types of suspensions. Where there is a structure of filaments which break down under shear, as in the cases of nitrocellulose solutions and the other polar colloids, the equation does not hold, for the material behaves as if it had a higher mobility and higher yield value, the higher the shearing stress. In order to secure greater clarity of exposition, let us first confine our attention to the one type of plastic flow (2). The typical fluids *OB* or *OC* are represented by Figure 5, the fluidity being measured by the tangent of the angle. A typical plastic curve *BCA* is also linear but the velocity of flow v vanishes at the finite shearing stress, $OA = f$. The mobility is measured by the tangent of the angle *BAD*. There are now four types of plastic substances which need recognition. Perhaps they will be found to fall under the following classification:

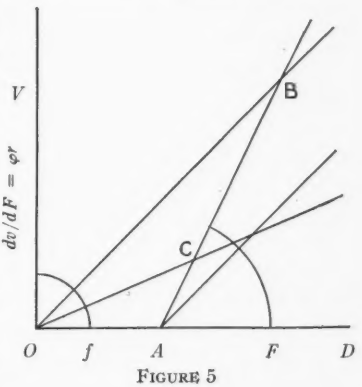


FIGURE 5

Short—The yield value is large and the mobility high.
Tough—The yield value is large but the mobility is low.

Tacky—The yield value is small but the mobility is high.
Long—The yield value is small and the mobility is low.

Butter, paint, starch, paste, printer's ink, and clay slip are excellent examples of short materials. If forced out of an orifice, short materials often collect in irregular masses, the yield value preventing the formation of a round drop. However, as the weight increases, it suddenly overcomes the yield value and since the mobility is high the mass quickly "necks off" and the mass drops off. Metals like case iron also exhibit shortness, which is a broader term than brittleness.

The condition is quite otherwise with molasses candy, gluten, or mixtures of linseed oil and rosin. When the material flows out from an orifice, it tends to form a round drop because the yield value is low, but when it falls due to gravity the necking-off process is very slow because the mobility is low. Hence, the material is stringy or ropy or simply "long." Many sorts of materials, such as glue, dough, paint, and even printer's ink, sometimes show noticeable and even troublesome length.

The third class of materials approaches the properties of rather fluid liquids while still being plastic on account of having a small yield value. A hot glue applied to a piece of board is at first thin and runny, *i. e.*, it has very high mobility and very little yield value; as the temperature is lowered or the water is absorbed, or both, the glue develops *tack, i. e.*, it seems sticky because the yield value increases and the mobility falls; with continuance of the same process on touching the glue with the finger or another piece of board no adhesion takes place because the high yield value and low mobility do not permit good contact to be made, but by means of pressure, heat, or long-continued contact adhesion may still result. Thus stickiness is not an absolute term but a relative one. Every one knows that pitch does not normally stick to the hands at ordinary temperature, yet if the hands are once wet with pitch, they will stick to pitch very readily. It is said that "glue cannot be made to stick to tin." This is hardly true. Tin is covered by a layer of grease, and when glue dries on grease-covered tin, the grease flows under the stresses created and the glue flakes off, but if the tin is cleaned well enough, the glue will stick. It is well known that glue will stick so firmly to clean glass that on drying it will pull a layer of the glass off resulting in a beautiful frosted effect and this process is used industrially. "Wet" paint or glue is tacky.

Finally, we find that there are substances which resist deformations whether long-continued but feeble or short and of great magnitude. Such materials are tough. We have tough metals, tough films of gelatin, rubber, and threads of silk.

The above terms have been found necessary in industry but they have not been recognized until now in science. There is no obvious reason why they should not be made respectable by being dressed up in the

clothes of exact definitions which alone will make them respectable. Since there is a continual tendency in literature to debase our verbal coinage, it would be a pleasure to see many of these old Anglo-Saxon words obtaining the dignity of some of their Latin cousins. The list of these words connected with flow might be greatly extended and they are being defined as a part of the official work of the American Society for Testing Materials, for in industry these terms need exact definition and measurement.

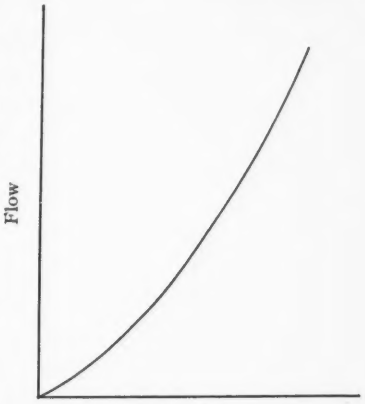


FIGURE 6

When "plastics" are made by pressure on a hot plastic material, it is necessary to have a nice adjustment of properties. The material must be soft enough to take shape readily, but it must not be tacky enough to stick to the mold, it must have yield value enough to maintain its shape after removal from the mold, and after cooling it should be hard and tough. Here is a good opportunity for the adjustment of the factors which make up plasticity.

Printer's ink is another case. If the ink is too long, it will cause the paper to stick to the type and the attempt to remove it may result in pulling off the surface of the paper, or the ink may even pull out in little strings which fall over and blur the half-tones. By adding vaseline to printer's ink it is made shorter. If the ink is too short, not enough ink will be deposited on the paper.

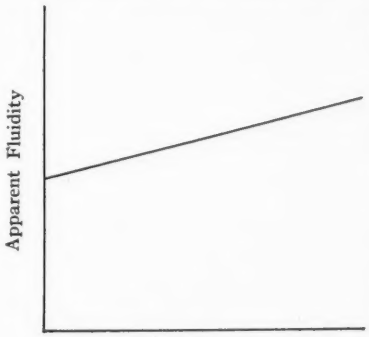


FIGURE 7

A few years ago a belting concern was having trouble because the belts stuck to the pulleys in warm weather and became so stiff as to actually crack and break in very cold weather. This required a study of the change of yield value and mobility with the temperature. It was found that the mobility had too high a temperature coefficient and the trouble was easily remedied.

In another case tests on paints were being made on a test fence,

using a panel for each sample. Made up to the same "apparent" viscosity, some of the paints remained on the panels as they should, but other paints ran off the fence. No one understood the trouble although the manufacturers of the latter type of paints claimed that their paints were not given a fair chance. It is clear from later work that the proper basis of test would have been to make them up to have the same yield value.

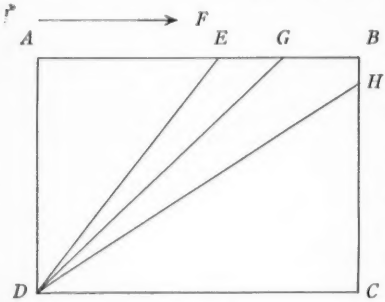


FIGURE 8

In the starch industry, things had a way of going wrong in the plant and the laboratory personnel could not tell when or why by means of their viscosity pipets. Finally, the knowledge came that they were not measuring the significant factor and the problem was solved through the measurement of plasticity. The manufacturers of linoleum have had a similar experience.

There are industries such as the nitrocellulose industry which are completely dependent upon the measurement of flow, but which have not yet found any particular advantages in using methods for the separation of the variables that go to make up plasticity. To be sure the problem is more complicated than is the problem of the non-polar colloid of the paint type, for the flow curve is not linear but increases rapidly with the shearing stress (Figure 6) as if the structure were being broken down. However, it appears that even this type of flow is dependent upon two variables only. Thus by plotting the apparent fluidity against the shearing stress one obtains the curve (Figure 7).

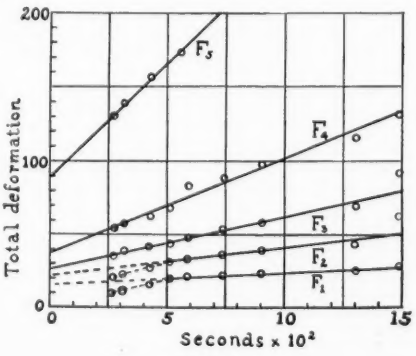


FIGURE 9

According to Van Rossen the measurement of plasticity is becoming a regular routine of the rubber industry but the deformation of rubber is quite largely elastic in character. This deformation has, in the past, been confused with the plastic deformation so that there was no way to measure accurately either the elasticity or the factors which go to make up the plasticity. The most promising

suggestion depends upon the fact that elastic deformation is nearly instantaneous whereas plastic or viscous deformations are a function of the time. The celebrated law of elasticity of that eccentric English scientist, Robert Hooke, is *ut tensio sic vis*, which may be rendered, "as the tension, so the stretch" or in mathematical language:

$$s = eFr$$

We may point out the relation to the law of viscous flow where s is a distance and V is a velocity.

$$V = \varphi Fr \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

In other words, if an elastic body $ABCD$ (Figure 8) is subjected to a shearing force, it is deformed at once let us say, to DE elastically. If it is a typical plastic solid, it then remains steady until the shearing stress overcomes the yield value, and even then it does not yield suddenly. The yielding is continuous and proportional to the time that the shearing stress acts. From the data obtained for ammonium oleate (Figure 9) one can see that it is possible to determine the deformation which would have taken place instantaneously by extrapolating back to zero time. The values obtained for the elastic deformation may then be plotted against the shearing stress (Figure 10) to show that Hooke's law does indeed apply to this class of materials to which it has not customarily been applied. The problem is not quite as simple as here presented, but the casual student of the subject need not be burdened with the details of measurement. For example, in Figure 9, it is observed that some of the curves are not quite linear near the origin due probably to inertia effects which are to be allowed for. It has proved disturbing to all earlier investigators that Hooke's law never holds quite exactly, which signifies that there is a little flow even below the yield value. This may be due to a variety of causes, among which are seepage and slippage. There is also an apparent

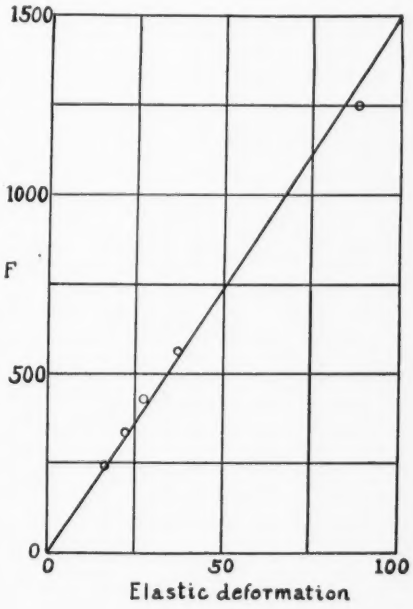


FIGURE 10

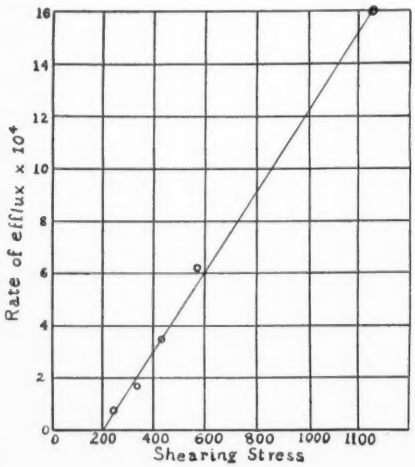


FIGURE 11

stiffening of plastic materials in flow called by Weber "the elastic after-effect." It is due to strains set up in the materials which tend to make the materials slowly "creep back" after a shearing stress is removed, unless this adjustment is hastened by "annealing." The heat of the annealing process lowers the yield value so that the strains can relieve themselves.

If one measures the rate of deformation (Figure 8) in excess of the elastic deformation, for several shearing stresses, one obtains data for the determination of the plasticity. In Figure 11 it appears that the plastic flow would take place at shearing stresses above 200 dynes per cm.^{2} and using this the mobility of a 43% solution has been found to be 0.055.

It will produce a vast simplification if all of the complex phenomena of flow can be reduced to a few fundamental properties of elasticity, yield value, mobility, and cohesion (or adhesion).

Hardness, strength, solubility, and melting point of colloids at first thought do not appear to be dependent upon plasticity measurements, but a closer study will reveal the fact that they *are* dependent upon plasticity and problems connected with these properties are awaiting investigations in the field of rheology.

In hardness tests indentations of specimens take place and the amount of indentation depends upon the time required. Hardness tests, as now made, are faulty since they give only a simple constant whereas plasticity is made up of two variables, both of which are presumably important. In fact, we have already proved that length and shortness, etc., can only be gaged after one has a knowledge of both of these variables. In regard to measurements of tensile or compressive strength, the same thing may be said; *viz.*, that the pulling apart of the specimen involves flow and the resistance to flow will largely depend upon the time taken to produce the flow.

FIGURE 12

Very slow flow of gelatin jelly behaving like a viscous liquid.

When a substance like nitrocotton is placed in a series of liquids, in some it swells and becomes dispersed in a colloidal solution. There is no limit of solubility in general which can be sharply determined as in aqueous salt solutions, but there are obvious differences in the flow, and there is sound reason for supposing that the solutions which are much more mobile show better dispersion.

In a similar fashion colloidal substances like butter, gelatin, glass, etc., have so-called melting-points or softening temperatures. The tem-

(*a*) (*b*) (*c*)

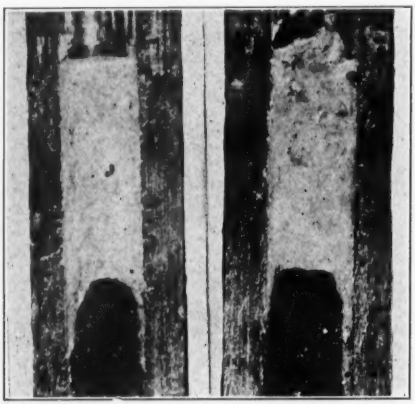
FIGURE 13

Plastic flow of suspensions of zinc oxide and lamp black at low shearing stress (*a*), high shearing stress (*c*), and intermediate (*b*). The black line in each case shows where the separation between the two colors was originally.

peratures are not true melting points and cannot be sharply determined. The plasticity, however, is real and can be sharply determined. In the case of butter, for example, there is a temperature at which the yield value disappears, *i. e.*, where it becomes a true liquid. This may be taken as the analog of the melting point. It is in reality the temperature of complete melting. There is, also, a temperature of complete solidification and therefore a solidification interval between these two temperatures. A great disadvantage of the ordinary melting-point determination of very

viscous materials is the uncertainty due to the slow diffusion in such a viscous medium, and it is needless perhaps to point out that in order for a crystal to either form or dissolve, a process of diffusion must take place. This difficulty can be completely overcome in plasticity measurements because no change of temperature takes place during the measurements which may therefore be continued as long as necessary.

In conclusion it may be instructive to demonstrate to the reader the different types of flow by showing first how a viscous liquid flows through a small tube so that after a time a plane surface AB becomes changed to a paraboloid of revolution as shown in Figure 12.



(*a*) (*b*)

FIGURE 14

Illustrating how in polar colloids a low shearing stress (*a*) produces telescopic flow throughout whereas a high shearing stress (*b*) causes the material to resemble in its flow the suspension under high shearing stress.

In plastic flow of a suspension such as zinc oxide or lamp-black in oil, the pattern of flow varies remarkably with the shearing stress as shown in Figure 13, (*a*), (*b*), and (*c*). The only difference among the three is that the flow in (*a*) is conducted at a very low shearing stress while (*c*) is at a high stress and (*b*) is intermediate. Since the material is not transparent the extruded material had been cut in two in the middle before photographing. Since flow takes place only when the shearing stress exceeds the yield value and the shearing stress is greatest at the wall of the tube, the flow in (*a*) seems to be complete "slippage" whereas at the highest shearing stress (*c*) the shearing of the material appears to take place throughout. In the intermediate case, the central portion of the material is shoved out as a solid plug. For these demonstrations the author is indebted to Mr. Baxter Lowe of Lafayette College.

But one must be careful not to draw too broad generalizations from the above because there are various types of plastic flow. For example, collodion made up of nitrocellulose, camphor, and dibutyl phthalate to a stiff paste flows in quite a different fashion, apparently in a manner diametrically opposite to that of the paint paste. This is shown in Figure 14 (*a*) and (*b*); as before the shearing stress is low in (*a*) and higher in (*b*). This behavior is readily explicable.

CHARLES MAYER WETHERILL, 1825–1871. PART II*

EDGAR FAHS SMITH

CHAPTER II

Consulting Chemist in Philadelphia

Upon Wetherill's return to Philadelphia, after a thirty days' voyage in a sailing ship, he proceeded at once to the establishment of an analytical laboratory and chemical school as announced upon the following:

CIRCULAR

Sir.

The undersigned, Doctor of Philosophy, of the University of Giessen, and late of the Laboratories of Paris and the Same, has opened a SCHOOL for Instruction in the various branches of CHEMISTRY.

Dr. W., having visited several of the most celebrated Laboratories of Europe, is enabled to combine their various advantages; but the plan which he has more especially adopted, as well with regard to the Course of Instruction, as in the Laboratory arrangement, is that which Prof. Liebig has pursued for the last twenty years with such signal success.

Terms (exclusive of Glassware, &c.) for the half year, $160. The year, $260.

Dr. W., will likewise turn his attention to the Analysis of ORES, the products of the Arts and Manufactures, &c.

CHARLES M. WETHERILL, *A.M., Ph.D.*

Laboratory, 206 Cherry St., Philad'a.
October 1, 1849.

The work which Wetherill did as a consulting and analytical chemist during the next four years was of a miscellaneous type and consisted of the analysis of ores, coals, inks, and numerous other commercial products. Business, however, was not always active and he utilized his leisure in conducting numerous miscellaneous researches in chemistry, varying greatly in character, and in preparing chemical lectures for the Franklin Institute which were delivered regularly in the courses of 1849–50, 1850–51, and 1851–52.

One of the earliest researches conducted by Wetherill during this period related to the mineral wulfenite of "light red color" from the Wheatley Mine near Phoenixville, Pa. It had been said that the color was due to chromium in the form of chromic acid. Wetherill wrote that he "was not able to detect chromium either by the moist way or before the blowpipe."[3] Blake had mistaken the mineral for chromate of lead, but Wetherill after a re-examination, not finding chromium, wrote of the wulfenite:

This compound may possibly be an acid molybdate, analogous to many chromates which when neutral are yellow, and red when acid.

* This is the last manuscript from the pen of the late Edgar Fahs Smith.

[3] *Proc. Acad. Natural Sciences* (Phila.), **6**, 55 (1852).

However, the mystery was cleared up by J. Lawrence Smith[4] who showed that the red color of the mineral was due to vanadic acid, amounting to more than one per cent.

An examination of the Food of the Queen Bee (the so-called royal jelly), revealed albumen and protein compounds which caused Wetherill to speak of it as a real bread containing an albuminous substance—probably similar to the gluten of wheat. As a consequence of this view there developed a series of speculative comments, terminating in no definite conclusions.[5] It was with reference to this research that Wetherill received a few years later the following letter from the celebrated apiarist, L. L. Langstroth:

Greenfield, Mass., August 15, 1855.

Dr. Charles M. Wetherill

Dear Sir:

In the month of June last I sent you thro Mr. W. Malin, of the Penna. Hospital some royal jelly for analysis. In the summer of 1852 you made an analysis of this substance, but the specimen was not large enough to give a perfectly satisfactory result. This jelly is the food, not of the mature Queen, but of the royal larva. The portions of wax in it are not constituent parts of the jelly but pieces of the comb broken and mixed with it at the time it was extracted from the cells. I am now publishing a second edition of my work on the Hive and Honey Bee and if you have been able to make an analysis of this second and larger specimen you would confer a great favor on me by sending me as soon as possible the result.

Yours very respectfully,
L. L. Langstroth.

It is not known what further investigations were conducted by Wetherill upon this interesting substance.

Among Wetherill's associates at this time was the distinguished Joseph Leidy who, prompted by the previous study, requested an analysis of several Mexican ants—the honey ants—and while the results were interesting, nothing of a marked character was observed beyond the demonstration that the acidity of the honey was due to formic acid.[6]

It was to be expected that circumstances would cause Wetherill to pay more or less attention to minerals, hence his observations on molybdenite, zircon, and the occurrence of gold in Pennsylvania.[7] He found upon one specimen of gold—that from Montgomery County—a grain of native tin—a very interesting observation. Many of the questions submitted to Wetherill and finally determined by him in his little laboratory were of an industrial nature, for example, the *Transactions of the American Philosophic Society*, **10** (new series), p. 353, contain an elaborate discussion on an asphalt

[4] *Am. J. Sci.*, II, **20**, 245.
[5] *Proc. Acad. Natural Sciences*, **6**, 119 (1852).
[6] *Ibid.*, **6**, 113 (1852).
[7] *Proc. Am. Phil. Soc.*, **5**, 273 (1852).

which eventually proved "to be a true and a new variety of asphalt" which he named "melan-asphalt."

Some attention was devoted to the fusel oil derived from Indian corn and rye which forced Wetherill to the conclusion that in nature and quantity of constituents the various specimens differed widely and that in those most exhaustively examined by him the quantity of fatty acids was exceedingly small.[8]

In 1851 Wetherill made an analysis of the illuminating gas of Philadelphia which is printed in the report of Engineer John C. Cresson to the Trustees of the Philadelphia Gas Works for Jan. 23, 1852. A more extended account of his work appeared in the *Journal of the Franklin Institute* for July, 1854, under the title "Examination of the Gas of the Philadelphia Gas Works." His methods of analysis are elaborated with great precision and reveal considerable discrepancies between his own results and those of other American investigators, particularly with regard to the presence of nitrogen of which Wetherill found only a trace. In this connection he very pertinently remarks:

> As will be seen by a comparison of these results with each other, and with my own, there is no agreement at all between them. Perhaps a publication of the details of the above-mentioned analyses would bring order out of apparent confusion. It is always well to publish details, for not only do they afford sometimes the only means of criticism, but are useful in preserving records of analyses from being lost, when from some newly observed fact a recalculation from the original data is necessary.

In reviewing the results contained in Engineer Cresson's report the Editor of *The Journal of Gas Lighting* (London), for 1852, page 439, makes the following facetious comments which reflect credit upon Wetherill's skill as an analyst:

> GAS LIGHTING IN PHILADELPHIA
>
> The following report contains, among much useful information, some particulars of a decidedly dubious character. Not content with astonishing us "Britishers" with sea serpents and other monstrosities of the material world, Brother Jonathan is determined that even the realms of science shall be invaded to supply the gullible propensities of John Bull. Accordingly, we here find some analyses of coal gas which set all previous things of this kind at defiance. What kind of article that mineral is to which the word coal has been applied in the United States, we dare not venture to say; but, if we may draw any conclusion from these analyses, it must have owed its origin to some vast collection of animal matter, perhaps a shoal or two of sea serpents, for the composition of the gas analysed by Messrs. Booth and Faber is such that the New York gas contains upwards of 20 per cent of nitrogen by volume, or about 40 per cent by weight, and about one-third of these quantities in Philadelphia. We were going to say that this out-Herod's Herod; but mean to say, that this out-Croll's Croll. Twenty per cent of nitrogen. The great cave of Kentucky is a fool to this gas, and ought immediately to be lighted up to preserve its reputation. True, indeed, Messrs.

[8] *J. Franklin Inst.*, **55**, 385 (1853).

Stewart and Alexander, in operating upon these same gases, very nearly reverse the proportion of nitrogen; but, then, these gentlemen contrive, from 100 measures of gas to obtain 100.24 measures, which, albeit everything is on the increase in America, looks rather suspicious. Then, again, we have an analysis of the Philadelphia gas by a Dr. Wetherill, which contains no nitrogen at all, or, at least, much less than what the chairman of the Great Central Gas Company calls "an infinitesimal small quantity." Dr. Wetherill's analysis, notwithstanding, looks so much like what we are accustomed to find in this country, that we give at once a decided preference to it, and venture to express an undiluted suspicion that the others are not worth "a brass button."

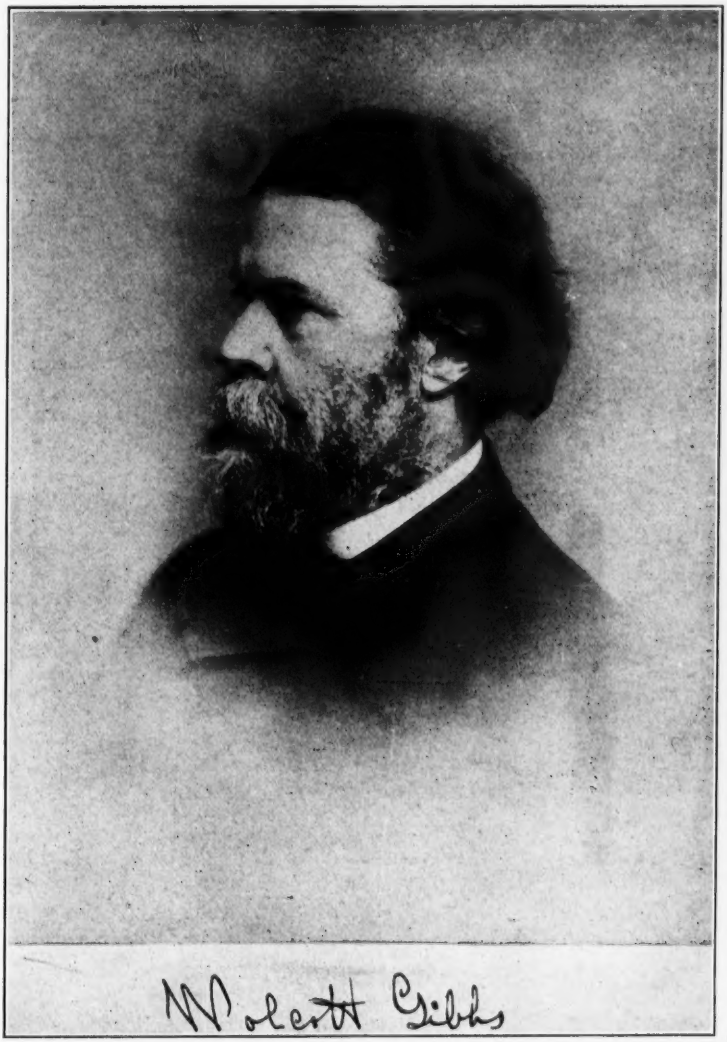
In the moments not given over to analysis or to more abstruse problems, Wetherill spent some time in his Philadelphia laboratory in efforts to improve certain forms of chemical apparatus; for example, he proposed a new apparatus for the determination of carbonic acid with fine balances. It was a substitute for the apparatus of Fresenius and Will which, in his day, was in universal use. The new device proved very successful, and was quickly adopted by the Rogers brothers, then doing much analytical work in connection with the Geological Survey. They had rejected the form of apparatus suggested by Fresenius and Will.[9]

Wetherill further modified Kemp's gas thermometer, making it more generally useful.[10]

It may be added also that he published rather exhaustive accounts of improvements made by himself in the furnaces used for the combustion of organic compounds. This was in a period when he and many others were eager to use a mixture of gas and air as the heating agent. They were desirous of eliminating the old charcoal furnaces. The publications by Wetherill bearing on this subject appeared in the *Journal of the Franklin Institute*, **57 & 58** (1854). Their perusal proved most interesting to the writer who could well appreciate the enthusiasm and the successful efforts of Wetherill in the development of this form of chemical apparatus. Chemists of that day were just as eager and alert to improve methods and apparatus as at any earlier or subsequent period. Today, Wetherill's contributions will be considered but momentarily, but they represent steps toward the present comforts which analysts have in their important work. The historian of the evolution of chemical apparatus will be delighted with the intelligent and rare skill displayed by Wetherill in his studies along these lines. He was constantly contributing devices useful in the laboratory and in the home,[11] engaging at the same time with marked success in the development of gas analysis.[12]

Of especial interest in this connection are a number of letters which

[9] *J. Franklin Inst.*, **55,** 333 (1853).
[10] *Ibid.*, **55,** 319 (1853).
[11] *Ibid.*, **58,** 121 (1854).
[12] *Ibid.*, **58,** 35 (1854).



(Oliver) Wolcott Gibbs (1822–1908), celebrated for his researches upon the ammonia cobalt bases and complex inorganic acids, graduated from Columbia College in 1841, obtained his M.D. degree from the College of Physicians and Surgeons in 1845, studied chemistry from 1845 to 1848 at Berlin, Giessen (under Liebig) and Paris (under Regnault), was Professor of Physics and Chemistry from 1849 to 1863 at the New York Free Academy (College of the City of New York), and occupied the Rumford Professorship at Harvard College from 1863 to 1887 when he retired as Professor Emeritus.

Wetherill received from Wolcott Gibbs regarding the purchase of one of his new gas furnaces:

New York, Feb. 7th, 1855.

My dear Wetherill:

Your kind letter reached me some time since as well as the notices you sent me a few days since for which I am truly obliged. I did not know when you wrote whether my funds would permit me to purchase one of your gas furnaces and now I can only afford to lay out about $15 for one. If, therefore, the simple gas furnace with 16 burners and capable of heating a tube 30 or 32 inches in length can be had at that price please to order one for me and send it so soon, as it can be got ready, to me by Express directing to the Free Academy, Corner of Lexington Avenue and 23rd St. I am hard at work with the Cobalt compounds. The investigation is very difficult and laborious and we have had to devise new analytical processes for almost every constituent but I think most of the difficulties are overcome now and that the results will be very striking. I should be very much pleased to see you here in New York. Our friend Hains is getting up new chemical tables and I have given him some hints about tables for gas determinations which will be very convenient and useful.

Very truly yours,
Wolcott Gibbs.

N. Y., Feb. 13th.

My dear Wetherill:

In reply to yours I have only to say that I think that the simple furnace for one tube 30 inches long will answer my purpose very well and the price is not exorbitant. The copper jacket I can have made here by a German workman whom I often employ. I should like however to have in addition the 3-way cock as it may be of use to me hereafter. I have a method of my own for organic analyses which is extremely convenient and preferable to the method by oxygen gas except when a large number of analyses are to be made. I have greatly improved Simpson's method of determining nitrogen. Please order the furnace as soon as possible. If you will let me know when it is finished I will send you a check for the $13 which I suppose is the most convenient way.

Very sincerely yours,
W. Gibbs.

New York, March 13th, 1855.

My dear Wetherill:

I was sorry to get such bad news about the gas furnace. However, it can't be helped and I wrote to Prof. Cooke of Cambridge for information about his Berlin furnace. He has promised to lend it to me for a few weeks and I shall then be able to judge whether I had better import one or not. I am a little afraid that the heat is not great enough to keep the metallic copper strongly ignited in nitrogen determinations. However, experience will test it easily. Where a great many combustions are to be made the method with oxygen gas and gas holder is certainly the best. But when only an occasional analysis is required I have a plan of my own which works to perfection. I take a combustion tube of the usual form and size; dry it thoroughly; introduce a few grams of $KO.ClO_5$ and CuO mixture; then an ignited plug of asbestos, then the substance *per se;* then, but leaving 2 inches space, another plug of asbestos. I then fill up at once with hot oxide of copper from the crucible. In this way no moisture can

be present. I heat the CuO rapidly at first then slowly as I approach the substance; then heat the substance till all the volatile matter is distilled over and burnt and then burn the residue with a slow current of oxygen. I draw dry and CO_2 free air through and finish in the usual way. The method is very easy to execute, as well as rapid, no time being lost or moisture gained in mixing. I am very sorry I have no Molybdänerz to send you. Why do you not import Mo* from Germany where it is now very cheap, *viz.* 12 gulden per lb.? They are making vast quantities in Bohemia for dyeing blue, etc. We have an excellent agent in the city now for chemical apparatus but are much in need of an importer of French chemicals.

Very truly yours,
Wolcott Gibbs.

* I mean molybdic acid almost *chemically pure.*

Two years later another inquiry regarding his combustion furnace was received by Wetherill from Dr. Thomas Antisell of the U. S. Patent Office, who a decade later became a successor of Wetherill as Chemist of the Department of Agriculture:

Washington
Patent Office
Nov. 15, 1857

My dear Wetherill:

Let me refresh your memory by recalling your attention to my existence: which for the last few months has pursued the even tenor of its way without disturbance either by elevation or dismissal which has made moves abundant around me. I believe I told you in a former letter that I was an assistant Examiner here in the Chem. Department in the office: a place not very suitable to me but which has kept the wolf from the door until in Micawber phrase something better turns up. We have connected with this (Chemical) room a small laboratory where we can keep in our fingers in old ways—and it is in connection with it that I chiefly now write to you: Our gas arrangements for ignition purposes are very incomplete and Mr. Schaffer and self thought if we could get your apparatus as described in the *Franklin Journal* it would be a great matter to us and I have written to you to know could we order a Tilghenaus burner, & a Burner holder such as you have described with a Burner for distilling purposes or Sand bath as found on pp. 274, 275 & 276 of Vol. **28** of *F. Journal*, from any one in Philadelphia or could you recommend us to a man who would do them for us & to let us know what sum probable would cover the expense of same: we have to get a sum allowed by the Commissioner for that purpose. Could you also tell us the cost of a Duffys Balance for coarse purposes—to weigh from 1 lb. downwards to a dram. We have already two fine balances but not one coarse one.

Situated as we are in a city where nothing out of the common run is to be had we have to depend on our friends for assistance. You will therefore excuse this trouble, & if I can be of any use to you here call upon me. May I enquire after your wife and ask whether she is a disciple of Malthus or not?

Believe me
Sincerely yours,
Thomas Antisell.

C. M. Wetherill, M.D.,
or &c.
Philadelphia.

As Wetherill's laboratory was evidently a center of activity along the lines of pure and applied science as well as in the studies of a more commercial character, we are prepared to meet an article by him entitled "A Chemical Examination of Baker's Bread of Philadelphia."[13] It has the character of a piece of work such as public analysts the world over are called on to make. The problem is an old one, and one which has been subjected to study and discussion for years, even down to the present.

It was in a similar spirit that Wetherill executed "Some Experiments on Coffee as a Beverage."[14] This study proved highly interesting and concluded with a condemnation of "those articles offered in the market under the name of extract of coffee" as being all "worthless and catch-pennies." Wetherill's investigations upon bread and coffee were a most useful public service and they entitle him to a place among these early chemists whose work marked the inception of the pure food movement in America.

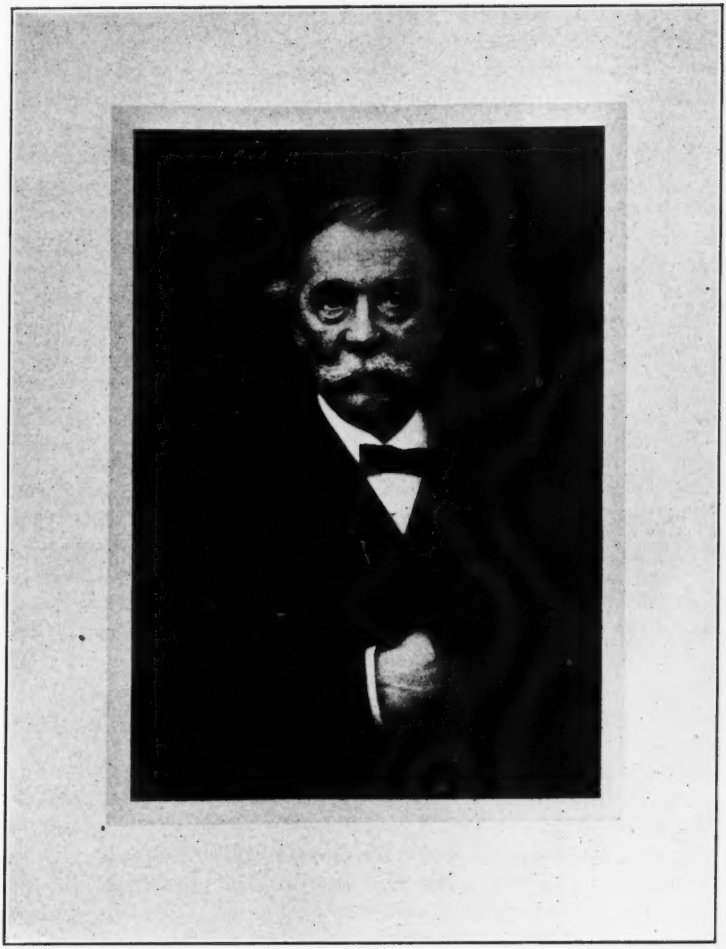
Wetherill's training under Liebig, the founder of modern agricultural chemistry, had a natural influence in directing his attention to agricultural chemical subjects upon which he began to submit various contributions to agricultural papers. Among the earliest of those is an interesting note upon the chemical composition of the ash of the cotton plant in *The Plough, The Loom and The Anvil* for February, **1853** (p. 89).

Wetherill's efforts to establish an analytical laboratory and school were not an entire success when viewed as a business venture. The conditions of the time probably did not warrant more than one establishment of this kind in a city even of the size of Philadelphia and Wetherill was not able to build up a large business in competition with the longer established and more widely known laboratory of Booth and Boyé where he had received his first practical training. Yet notwithstanding the discouragements which every young chemist must experience in beginning the practice of his profession, Wetherill courageously resisted all inducements to draw him away from the course which he had originally planned. On September 30, 1850, he received from the U. S. Treasury Department in Washington, over the recently opened Morse Line of The Magnetic Telegraph Company, the following telegram:

> Will you accept the office of Assayer of the U. S. for California? Salary five thousand dollars. Answer immediately.
>
> *R. S. McCulloh*

This attractive Government offer, which was a result of the developments following the discovery of gold in California in 1848, could not, with all its promises of new adventure, lure Wetherill from the pursuit of the scientific and business career which he had mapped out for himself in Philadelphia.

[13] *J. Franklin Inst.*, **29**, 386 (1855).
[14] *Ibid.*, **30**, 60–111 (1855).



ROBERT OGDEN DOREMUS (1824–1906)

Robert Ogden Doremus, well known as a teacher and brilliant lecturer in chemistry, graduated from New York University in 1842; after working for a number of years as an assistant of Professor J. W. Draper, he studied chemistry at Paris in 1847, obtained his M.D. from New York University in 1850, became one of the founders of the New York Medical College in 1850, elected Professor of Natural History in 1851 at the New York Free Academy (College of the City of New York) of which he became Vice-President and from which he retired in 1903 as Professor Emeritus; elected Professor of Chemistry and Toxicology at Bellevue Hospital Medical College in 1861. An appreciative sketch of his career and wonderful personality is given by L. S. Burchard in *The City College Quarterly* for 1906, pages 221–234.

But although not leading to a permanent position in life, the years which Wetherill spent in his Philadelphia laboratory were by no means wasted. The chemical researches which he performed in his native city between 1849 and 1855 were of high quality and quickly led to honors and recognition. On January 17, 1851, he was elected a member of the American Philosophical Society, and on March 3, 1853, he was awarded the honorary degree of M.D. by the New York Medical College, of which Wetherill was first informed by the following letter from his life-long friend, Dr. R. Ogden Doremus:

New York Medical College
March 4th, 1853.

To,
Charles M. Wetherill, Ph.D., M.D.

Sir,

I have the honor of informing you that at a meeting of the Board of Trustees of the "New York Medical College," held on the evening of March 3d, 1853, at the recommendation of the Faculty of said Institution and because of the evidence laid before the Board of your success in Chemical investigations, which are deemed an earnest of your future achievements in a department of Science eminently allied to Medicine, if not destined to form its basis;

On motion,

It was resolved,

That the Honorary degree of Doctor of Medicine be conferred by this Institution on Chas. M. Wetherill, Ph.D., of Philadelphia, Penna.

Very respectfully
Your obedient servant
(SEAL) *R. Ogden Doremus, M.D.*
Secretary of the Board of Trustees of the N. York Medical College.

In the field of medical chemistry Wetherill's best known contribution was a very thorough investigation "On Adipocire and Its Formation," which was read before the American Philosophical Society on January 19, 1855, and published in its *Transactions* for that year. At the close of 1853 Wetherill visited a grave-yard of Philadelphia, where the remains were being removed, and collected two specimens of adipocire which came from the bodies of large persons who had been buried from five to fifteen years. His investigations upon the chemical and physical properties of these samples and upon the artificial formation of adipocire which he produced by burying a bullock's heart in wet sand, extended during various interruptions from December, 1853, until February, 1855. Wetherill's investigation upon adipocire was widely abstracted and it gained for its author a considerable amount of prestige.

"A man who cannot think, no matter how many facts he has stored in his memory, is not educated."—WOODROW WILSON

THE ALEMBIC CLUB AND THE HISTORY OF CHEMISTRY

LEONARD DOBBIN, SECRETARY OF THE ALEMBIC CLUB,
BLACKSHIELS, MIDLOTHIAN, SCOTLAND

Forty years ago regular lectures upon the history of chemistry were included in but few, if in any, of the courses of instruction in chemistry in the universities of the English-speaking nations, and textbooks on the subject in the English language were almost non-existent. Historical sketches, tracing for the most part in a general manner, and with little attempt at details, the progress of chemistry, were included in some encyclopedias and also in a number of the older textbooks, notably in the English version of Boerhaave's "Elements," dating from about 1732, and in the various editions of Brande's "Manual of Chemistry," the first of which was published in London in 1819 and was followed by numerous other editions, several of them American and published in New York.[1] The "History of Chemistry," in two volumes, by Dr. Thomas Thomson, Professor of Chemistry in the University of Glasgow, which was published in 1830, was, at the period referred to above, the only existing English work which made any pretensions to giving a detailed account of the subject, and, while it was interesting and eminently readable, it was then more than half a century old, and, moreover, had been long out of print.

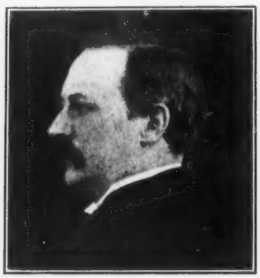
The condition of deficiency which thus existed was materially ameliorated by the publication in 1891 of an English translation of Professor Ernst von Meyer's "Geschichte der Chemie" (first German edition, 1889) and since that date quite a variety of larger and smaller historical compilations have appeared in different editions, both in the United States and Great Britain, so as to supply all ordinary educational requirements.

In the same year that von Meyer's "Geschichte" appeared in Germany, that is to say, on October 29, 1889, in the capital of Scotland a small circle of chemists, consisting of the five non-professorial members of the teaching staff in the Chemistry Department of the University of Edinburgh, formed themselves, under the title of "The Alembic Club," into an unassuming body which was destined later to play a useful part in bringing important historical material connected with chemistry within the reach of interested readers.

The idea of forming the Club originated with the senior assistant on the departmental staff and was taken up with enthusiasm by the other members. In order of seniority the original members of the Club were:

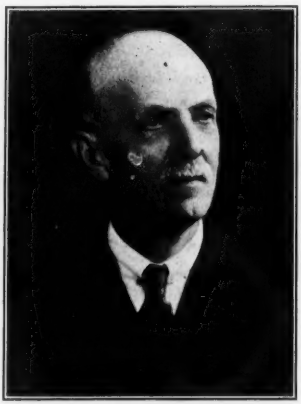
[1] Neither the Macneven nor the Webster American editions of the Brande text, it may be mentioned, preserved the "very concise but excellent historical sketch" contained in the original (see Edgar F. Smith, "Old Chemistries," McGraw-Hill Book Co., **1927,** p. 84).

(1) JOHN GIBSON, a native of Edinburgh. He was a student with Bunsen at Heidelberg and was elected Professor of Chemistry in the Heriot-Watt College, Edinburgh, in 1892. It is of interest to note that he was a grandson of a former John Gibson who had been the law adviser and intimate personal friend of Sir Walter Scott during the later years of the famous author's life, at the time when he was harassed by financial trouble. He was the co-originator, with Crum-Brown, of the famous Crum-Brown-Gibson rule for determining the position of radicals entering a substituted benzene nucleus, and after holding the Chair of Chemistry at the Heriot-Watt College, Edinburgh, for many years, died in 1914. His only son is a professor of chemistry in the University of California.



JOHN GIBSON*

(2) LEONARD DOBBIN, born in Belfast, Ireland. He studied chemistry with Andrews in Belfast, with E. Frankland at South Kensington, London, and with Wislicenus at Würzburg, Bavaria. He was appointed lecturer in chemistry in Edinburgh University in 1904 and reader in 1920, retiring in 1924. Since the inception of the Club Dr. Dobbin has functioned as its secretary.



LEONARD DOBBIN

(3) HUGH MARSHALL, born in Edinburgh. He studied chemistry with Crum-Brown in Edinburgh University and also attended classes in Munich and Ghent. His discovery of the persulfates resulted in his election as a fellow of the Royal Society in 1904. After holding the position of lecturer in crystallography in the University of Edinburgh, he was appointed to the Chair of Chemistry in University College, Dundee, in 1908, and died in 1913.

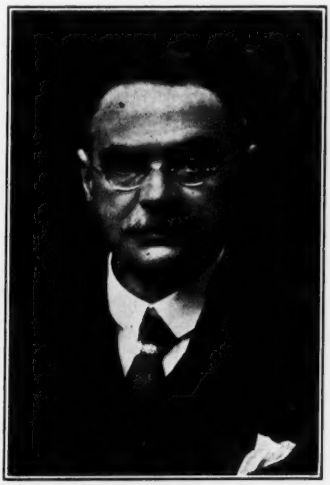
(4) JAMES WALKER, a native of Dundee. He studied chemistry with Crum-Brown in Edinburgh University and with Ostwald in Leipzig. He succeeded P. F. Frankland in the Chair of Chemistry in University College, Dundee, in 1894, and Crum-Brown in Edinburgh University in 1908. His "Introduction to Physical Chemistry" has been the standard book in the field since 1899, and has passed through many editions. His researches on solutions were

* The original photograph for this cut was kindly loaned us by Dr. Gibson's sister-in-law, Frau Prof. Wytzes, M. Gladbach, Gartenstr. 14, Germany.

recognized by the award of the Davy Medal of the Royal Society in 1926. He retired in 1928.[2]

(5) ALEXANDER SMITH, a native of Edinburgh. After studying chemistry with Crum-Brown in Edinburgh University and with von Baeyer at Munich, he held the position of professor of chemistry and mineralogy in Wabash College, Crawfordsville, Indiana, for some time, but was soon called to assist in the development of the University of Chicago, where he remained for seventeen years. In 1911 he succeeded Professor Chandler at Columbia University, and served as head of its department of chemistry until serious illness compelled his retirement in 1919. His research work on the allotropic forms of sulfur and his series of textbooks on inorganic and general chemistry will be familiar to all readers. He died in 1922.[3]

HUGH MARSHALL



JAMES WALKER

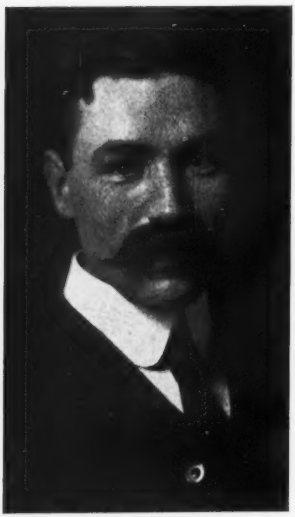
One member was elected subsequently (in 1891):[4]

(6) RALPH STOCKMAN, born in Leith (the port of Edinburgh). He studied medicine at Edinburgh University, Vienna, and Strassburg, and was elected in 1897 professor of materia medica at Glasgow University, a position which he still holds.

[2] A description of the New Chemistry Laboratories of the University of Edinburgh from the pen of Sir James Walker appeared in THIS JOURNAL, **4**, 570–3 (May, 1927).

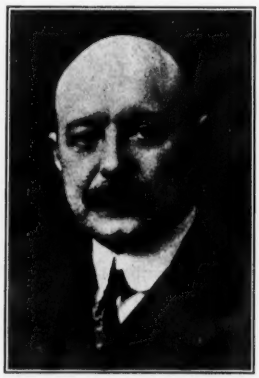
[3] An obituary notice of Alexander Smith will be found in the *J. Am. Chem. Soc.* for December, 1922. See also an editorial in THIS JOURNAL, May, 1927.

[4] Professor James Kendall, now occupying in Edinburgh University the Chair of Chemistry vacated in 1928 by Sir James Walker, was admitted to membership to the Club on May 17th of this year.



Jubilee Number, J. A. C. S.
ALEXANDER SMITH

The members arranged to hold periodical meetings with a view to promoting, by discussion and otherwise, the three main objects of the Club, *viz.*, (1) to secure the better recognition of the University of Edinburgh as a school of chemistry and center of chemical research; (2) to encourage the study of the history and literature of chemistry; and (3) to further the professional advancement of its members. Under its constitution the Club was to consist of *ordinary* and *corresponding* members. The number of the former was limited to seven and of the latter to thirteen. Ordinary members had to be resident in or near Edinburgh and were to become corresponding members automatically when they ceased to reside in its neighborhood. Certain rules for the regulation of the Club's activities were agreed to at its inaugural meeting, some of which may be briefly indicated here. Ordinary meetings were to be held monthly, in the evening during session time, at the residences of the members in rotation, and members who did not attend were subject to fine. New admission to the Club was only to be given by the unanimous vote of the members—a rule which came into operation only once, on the admission of the sixth member in 1891. With the intention of showing disregard for the superstition attaching to the number thirteen, a special rule appointed as the date on which annual subscriptions become due, the fifteenth day of December, this, the 349th day of the ordinary year (leap year excluded) being the thirteenth day of the thirteenth month of a year supposed to begin at New Year's day as at present, and made up of thirteen months, each consisting of twenty-eight days and with one day over (two in leap year). The Club's rule thus pointed to a reformed type of calendar which has been seriously proposed in quite recent times, although it is to be noted that the question of the disposal of the odd day (two in leap year), as not coming within the purview of the members, was left



RALPH STOCKMAN

to others for decision. An unwritten rule required each member on appointment to a university chair to entertain his fellow-members at the festive board, and this was duly observed on five auspicious occasions.

The monthly meetings of the Club were started immediately after its inauguration and the members busied themselves preparing reports upon current chemical papers of an outstanding description and in reviewing and discussing the more important investigations of earlier date. It was at a very early stage in the existence of the Club that the resolve was taken at one of these meetings to publish some of the less easily accessible chemical classics in convenient form as simple reprints or as translations, and in a few years a useful series was rendered available to teachers and students of chemistry, as well as to general readers, under the title of *Alembic Club Reprints*. It was fitting that the first of these reprints should present Black's world-renowned "Experiments on Magnesia Alba, etc.," in view of the author's occupation for many years of the Chair of Chemistry in Edinburgh University. This reprint appeared in 1893 and was followed in succeeding years by reproductions of papers and extracts of fundamental importance from the writings of Avogadro, Berthollet, Cannizzaro, Cavendish, Dalton, Davy, Faraday, Gay-Lussac, Graham, Guyton de Morveau, Hooke, Kolbe, Mayow, Pasteur, Priestley, Rey, Scheele, Thenard, Thomson, Williamson, and Wollaston, all of whose names are famous in the history of chemistry. The most extensive volume of the reprint series was Mayow's "Opera Omnia," which supplied a complete English translation of the five separate treatises written originally in Latin in the 17th Century by the noted Oxford philosopher. The most recent addition to the reprint series presents translations of the highly important papers by van't Hoff and Arrhenius,[5] published in the first volume of Ostwald's *Zeitschrift für physikalische Chemie*, which form the foundations of the theory of dilute solutions.

A further contribution toward stimulating the study of chemical history was made by the publication by the Club of a translation of Ladenburg's interesting and popular "Lectures on the History of the Development of Chemistry since the Time of Lavoisier." This passed through two editions during the lifetime of its author, but it is now out of print.

Tributes to the usefulness of the Club's publications have been received from numerous teachers and references to them are to be met with in many standard textbooks, while as material for class study various volumes of the reprint series have from time to time been adopted in different American and British universities.

[5] A review by Tenney L. Davis of this reprint will appear in the October issue of THIS JOURNAL.

THE RELATION OF CHEMISTRY TO HEALTH AND DISEASE*

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Good health is one of man's most precious possessions. It is hard to realize how much the chemist and bacteriologist have done to better living conditions until one studies the conditions which existed prior to the nineteenth century.

Early man longed for health even more than we do today. He understood the value of preventive medicine;[1] he had learned that medicines from certain herbs cured certain diseases—sometimes. He had no laboratory in which he could test the strength and purity of his herbs.

MARION P. ADAMS

As time passed, we find that the Arabs studied physiology and hygiene. Their surgeons understood the use of anesthetics and performed some of the most difficult operations known. At that time the practice of medicine in Europe was forbidden by the Church.[2] This prevented the knowledge of the Arabs from spreading to Europe.

There have been several theories for the cause of disease. In primitive times, man thought sickness was caused by demons which inhabited the body.[3] It will be remembered that later, in Bible times, many sought Jesus so that he might cast out the demons. They did not seem to believe that all sickness was caused by demons, for there were many who simply asked to be healed. Still later came the punitive theory when man believed that an outraged deity sent punishment and death for his sins.[4] The Greeks and Romans believed that the vapors rising from certain

* Prize-winning college essay, 1928–29.

[1] Moore, Harry H., *Public Health in the United States*, pp. 3–4.

[2] Wells, H. G., "Outline of History," p. 610.

[3] Moore, Harry H., *op. cit.*, p. 13.

[4] *Ibid.*, p. 73.

grounds were very dangerous, and night air was greatly feared.[5] This false theory has been revived.

During the middle ages, the alchemists earnestly, but vainly, searched for the "philosopher's stone" which would give the "elixir of life." The science of alchemy was replaced by the science of chemistry in 1525.[6] With it came a doctor, Phillipus Aureolus Paracelsus Theophrastus Bombastus, who is more commonly known as Paracelsus. He argued that the body was composed of chemicals and that when the body was ill it was because of a lack of some of these chemicals, which should be replaced. Needless to say, there were a few unfortunates who suffered death when Paracelsus did not supply the proper chemical, but they gave their lives in a cause which accomplished a great deal—the union of chemistry and medicine. From this time, the doctor and the chemist worked together.

The next decisive step against disease came in 1796, when Edward Jenner originated cowpox inoculation to counteract smallpox.[7] Up to this time, the terror of smallpox had been felt by rich and poor alike, but this inoculation has saved thousands of lives yearly.

During the latter part of the nineteenth century, a series of important discoveries were made which effected a great change in the knowledge of health. The first of these was the discovery of bacteria. It might be better to term it rediscovery, for in the seventeenth century Leeuwenhoek, with his homemade microscope, had first entered this unseen and unknown world when he found his "wee beasties" in rain water.[8] Pasteur rediscovered bacteria when he made his study of fermentation in an effort to benefit the wine industry of his country. Later, in 1865,[9] he was asked to make a study of the silkworm industry. This research was the first to show that disease is caused by small organisms, and also showed how the organisms are transmitted, and how this transmission may be checked.[10] He saved many dollars annually for these industries, but he did not think so much about this saving; instead he looked toward the future, and he asked himself just how much influence this hitherto unknown world had on human beings.

Now that the enemy had been recognized, the next question was how to overcome disease. Pasteur and his followers dreamed of health for all and set out to attain it. The first step was vaccination, which Pasteur stumbled upon when he was working on chicken cholera. Then he developed progressive vaccination when he was studying the deadly anthrax

[5] Moore, Harry H., *op. cit.*, p. 73.
[6] Chemistry course.
[7] *Ibid.*, p. 76.
[8] DeKruif, Paul, "Microbe Hunters," pp. 10–11.
[9] American Public Health Association, *Half Century of Public Health*, p. 15.
[10] Caldwell, Otis W., "Science Remaking the World," p. 141.

disease. The public was not convinced of the value of vaccination, so a public demonstration was held. The vaccinated cattle and sheep were immune, the unvaccinated died. Pasteur was wildly applauded. Next, Pasteur studied rabies and perfected vaccination for hydrophobia, and Emile Roux, his understudy, perfected a toxin-antitoxin with which he vaccinated children sick with diphtheria.[11] Before Roux perfected vaccination, it is said that fifty out of every hundred children who entered the Hospital for Sick Children died of this disease.[12] Keeping this death rate in mind and thinking for a moment of the agony which these poor children suffered, it is easy to understand the relief of the mothers when this preventive was introduced.

Dr. Joseph Lister, in 1867,[13] introduced antiseptic surgery. Up to this time, there had been no way of combating infection which appeared after surgical operations. Lister had read of Pasteur's study of fermentation and applied the idea to antiseptics. Another outcome of Pasteur's study of fermentation was the pasteurization of milk.

As science tried to find ways to prevent disease, it realized that it must find how the disease spread from one individual to another. The search was carried on in many parts of the world and showed several methods of transmission. Pasteur was the first to show how disease was caused and how it spread. Robert Koch showed that anthrax was spread among sheep only when the healthy animals came in contact with the anthrax bacilli or spores of bacilli which were contained in the tissue of a dead animal.[14] He told the farmers that they must burn the bodies of the dead animals or bury them very deep so that the bacilli could not rise to the surface to infect healthy sheep.

The scientists of the nineteenth century revealed many carriers of disease, human and otherwise. Theobald Smith, in Texas, proved that baby ticks carried Texas fever to healthy cattle.[15] David Bruce, in Uganda, discovered the tsetse fly carrying the deadly trypanosomes of sleeping sickness from antelope to man,[16] and started the war against sleeping sickness which is still going on.

Ronald Ross, in India, proved that mosquitoes carried malaria among birds, but it was Battista Grassi,[17] in the lowlands of Italy, who convicted the anopheles mosquito of carrying human malaria.

Yellow fever was the subject of much controversy in the medical and health journals of the nineteenth century. The disease would suddenly

[11] DeKruif, Paul, *op. cit.*, p. 202.
[12] *Ibid.*, p. 202.
[13] American Public Health Association, *op. cit.*, p. 15.
[14] DeKruif, Paul, *op. cit.*, p. 122.
[15] *Ibid.*, p. 249.
[16] *Ibid.*, p. 274.
[17] *Ibid.*, pp. 296 and 308.

appear in a town, and the people would not know who would be the next victim. Both the cause and the carrier were unknown. They frantically tried different remedies—fumigation, burning, but to no avail. The only way of escape seemed to be to leave the stricken town.[18] Then the United States Government sent Walter Reed to Cuba with instructions to "give special attention to questions relating to the cause and prevention of yellow fever." It was not an easy task, but he accomplished it. He proved that the yellow fever was carried from the sick to the healthy by the Stegomyia[19] mosquito, and that yellow fever could be prevented if this mosquito was destroyed.

It has also been proved that fleas carry the plague from diseased rats to men, and the war against plague developed into a war against rats.

Robert Koch, in India, showed that the common bacillus carried cholera, and how it lived in polluted water. He said that India would not be freed from cholera until she practiced sanitation.[20]

Typhoid fever may be carried in several ways. The first cases in the Maidstone outbreak in 1897 were caused by contaminated water, but after this cause was eliminated, two hundred eighty cases occurred from direct or indirect contact with the sick. It has been proved that a few persons who have recovered from typhoid fever may excrete the bacillus for two years after illness. Food grown on polluted soil, and dust, flies, and clothing may also be carriers.[21]

Robert Koch, in Germany, discovered the tubercle germ and showed how tuberculosis was spread from one person to another by inhaling the germs in dust, or by the coughing of people sick with the disease.[22]

The scientists of the nineteenth century encountered many difficulties when they made their studies of the various diseases. There was no trail to follow; so, like true pioneers, they blazed their own. By a lucky chance, Koch found that he could isolate a germ on a solid surface and that the germ grew and did not mix with any other kind of germ.[23] This was a great improvement on the broth culture which was first used. Later, Koch mixed gelatin with beef broth so that he would get a solid surface when the gelatin solidified.[24]

When chemists began to work with the possibilities of coal-tar products, they little realized what a wide field they were opening up. Today, medicines, anesthetics, antiseptics, and aniline dyes are all made by the

[18] De Kruif, Paul, *op. cit.*, pp. 312–3.
[19] *Ibid.*, p. 308.
[20] *Ibid.*, p. 142.
[21] *Encyclopaedia Brittanica*, Volume XXVII, pp. 506–7.
[22] DeKruif, Paul, *op. cit.*, p. 136.
[23] *Ibid.*, pp. 125–7.
[24] *Ibid.*, pp. 125–7.

chemist, and he is not limited to the materials found in nature.[25] When he does not find what he wants in Nature's cupboard, he creates a new product. In 1874,[26] Kolbe made the first medicine from coal tar, when he secured salicylic acid from carbolic acid. Coal tar also furnishes aspirin and other "headache" remedies.[27] Some of the anesthetics which have brought comfort to many people are cocain, eucain, and novocain; and among the antiseptics are listed flauvine, carbolic acid,[28] and mercurochrome.[29]

Weighert, in 1871,[30] taught us how to use the basic aniline dyes for staining bacteria. Paul Ehrlich believed in the possibilities of these dyes and it was he who showed Robert Koch how to stain the tubercle microbe.[31] Ehrlich's work with aniline dyes led him up to the discovery of "606" which is the product of very skilful chemical synthesis. He actually changed a compound which contains deadly arsenic to a successful weapon for fighting syphilis.[32]

These searchers accomplished a great deal of work. Practically every disease which was studied was a disease which occurred in epidemic form and took thousands of lives. Until science discovered their cause and means of prevention, there was a very high death rate and a great financial loss. Some of these diseases have been practically eliminated, but others, such as tuberculosis, still have a high death rate even though it has been reduced.

We have already learned how Koch, in 1883,[33] showed India that she must practice sanitation if she would wipe out cholera. Many years before that, the value of sanitation had been recognized by Rome; large sums of money were spent in taking care of sewage, and purifying the water of the polluted Tiber which was used for drinking water. During the Dark Ages, filth and pestilence prevailed and Europe was scourged with disease. In the middle of the nineteenth century, an epidemic of cholera broke out in London which led to a revival of sanitation and the establishment of water and sewage systems in London.[34] It has been shown that polluted water causes typhoid fever.

Modern sanitation has introduced the use of chlorine and chlorine lime

[25] Slosson, Edwin E., "Creative Chemistry," pp. 85–7.
[26] *Ibid.*, pp. 86–8.
[27] *Ibid.*, pp. 86–8.
[28] *Ibid.*, pp. 86–8.
[29] Farrell, Hugh, "What Price Progress?" p. 208.
[30] American Public Health Association, *op. cit.*, p. 71.
[31] DeKruif, Paul, *op. cit.*, p. 336.
[32] *Ibid.*, pp. 350–1.
[33] Moore, Harry, H., *op. cit.*, p. 75.
[34] *Ibid.*, pp. 5–6.

compounds to disinfect sewage.[35] Most of the larger cities now have water purification plants which can purify the most polluted river waters. In 1904, Columbus, Ohio, had a death rate of 120 per 100,000 inhabitants, but after a water purification plant was installed this rate dropped to three for each 100,000 inhabitants in 1920.[36] In the last yearly report of this city, the cost of lime, soda ash, alum, and chlorine per one million gallons of water treated amounted to $14.00,[37] a small cost when one stops to think of the decrease in the death rate and its cost. All through the United States the health rate has shown a greatly reduced death rate. Howe's "Chemistry in Industry" shows that twenty-two United States cities showed decreases ranging from 61 to 89%.[38] All of which emphasizes the fact that good health is far cheaper than poor health and disease.

After science had shown how to combat disease, Public Health Service was created to carry on the task. Three states, Massachusetts, California, and Virginia, and the District of Columbia had boards of health prior to 1872.[39] Today, every state has its board of health. There are also county and city boards of health and the United States Public Health Service. In all of these organizations, the chemist and the bacteriologist are continually fighting the diseases which have not been conquered. The United States Public Health Service handles the suppression of epidemics. The state boards of health handle the control of communicable diseases, maintain diagnostic laboratories, furnish antitoxins and serums free or at cost to those who cannot afford to pay for them.[40] The prompt service of these diagnostic laboratories has prevented many epidemics; their antitoxins and serums have protected many communities from the chance of infection. The state laboratories also furnish diagnosis and treatment for venereal disease. This service is free or at cost.

Bacteriology was made possible by Pasteur, and our knowledge today is based on the discoveries of Pasteur and the searchers who followed his lead. Bacteriology has taught us the cause of disease and its carrier; it has taught us methods of diagnosis and immunization, and methods of curing disease and saving lives by the use of vaccines, sera, and antitoxins; and it has taught us the parts played by air, water, sewage, milk, and insects in the spread of disease and has developed for us special methods of protection.[41]

One duty of the modern bacteriology department is the inspection of food

[35] Howe, H. E., "Chemistry in Industry," Vol. II, p. 387.

[36] McPherson and Henderson, "General Chemistry," p. 583.

[37] Hoover, Charles P., "Water Softening and Purification at Columbus, Ohio," *Water Works*, Volume LXVII, No. 6, p. 239.

[38] Howe, H. E., *op. cit.*, p. 392.

[39] American Public Health Association, *op. cit.*, p. 14.

[40] Moore, Harry H., *op. cit.*, pp. 214–5.

[41] American Public Health Association, *op. cit.*, p. 90.

and drugs. Pure drugs insure certainty. The first vaccines were carelessly prepared without thought of sanitation which made the remedy very dangerous.[42] The United States Public Health Service inspects all antitoxins and toxin-antitoxins made in commercial laboratories doing an interstate business, and it also inspects the establishments.[43] The inspection of milk and water are important duties of state boards of health.[44] They also maintain a service for the tuberculin testing of cows.

Research work is continually going on among the workers in bacteriology. Many organizations of physicians, sanitarians, health officers, and other trained workers are constantly studying health problems from a scientific angle.[45] They differ from the alchemists, for they publish their work so that all may benefit from a common knowledge and enlarge upon it.

Pasteur would be a happy man if he could see the large number of men in laboratories and research institutes who are working together for the benefit of all. A great deal has been accomplished since Pasteur founded the science of health, but there is still a great deal to be done. The world can use a second Pasteur.

[42] Farrell, Hugh, *op. cit.*, p. 209.

[43] Moore, Harry H., *op. cit.*, p. 102.

[44] *Ibid.*, p. 225.

[45] Williams, R. C., "Scientist in Public Health," *Hygeia*, **6**, 403 (1928).

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Rubber Oil for Mosquitoes. It has been found that rubber oil, made from old worthless scrap and reclaimed rubber by acid methods is a deadly foe to mosquitoes, the spreaders of malaria. It is claimed to be even more effective than mineral oils in checking this disease-spreading pest.—*Catalyst*

CHEMISTRY AND ITS RELATION TO THE ENRICHMENT OF LIFE*

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An attempt to trace in untechnical terms the rapid advance of a purely technical science that has always remained more or less a mystery to the lay mind.

The old alchemist was writing; the top of the goose-quill came almost up to his eyes as he scrawled upon the parchment a sentence that embodied the intricacies of his craft: "The fierce serpent is tamed and the dragon is so subjected as to oblige him to devour his own tail." That was his chemical formula. The guttering flame of an oil lamp threw weird shadows over the jumbled array of retorts and tubes and bottles; it shone upon the dirty astrological charts and the tattered row of mystic Latin books. As he wrote, the old fellow watched carefully the liquid that was seething in the pan over the fire. He was seeking to make gold from the common metals; and he was groping in darkness. His art was a phantom process with few useful applications. Half dreamer, half quack, he clothed his acts with a foolish mysticism and struggled with a nebulous science closely interwoven with superstition. The world before his door was still at grips with nature. Disease spread rapidly and there was no power to check it; man but clumsily wrested materials from the earth to build his houses and his machines; crops grew haphazardly; sanitation was an absurdity; everywhere man was taking things more or less as he found them. There was a sparsity and a crudeness to life, an unfinished roughness that somehow dulled the edge of things.

THOMAS ROSSER REEVES, JR.

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The modern chemist was working in his laboratory. He was trying to

* Prize-winning college essay, 1928–29.

obtain phosphorus as a concentrated acid, so that by a reduction of inert materials in the known fertilizers agriculture all over the world would be stimulated and advanced. Smoothly working gas burners blew hot points of smokeless flame against tubes and beakers of clear glass; electric lights gleamed upon thousands of bottles of chemicals; a chart of the atoms hung upon the wall. With mathematical accuracy the chemist worked out his formulas; expertly and easily he balanced cubic centimeters against grams; he juggled with liters and atoms, temperatures and kilograms. Superstition and mysticism had vanished before a great science with thousands of practical and useful applications; the world before his door had pried deeply into the secrets of nature. Disease struggled against the barriers of preventive medicine; crops prospered under scientific fertilization; metals from the earth were made cheap and pure and plentiful through chemical means; fast automobiles in bright colors flashed along level roads of concrete; giant buildings with metal ribs reached dizzily into the sky; airships braced with metals stronger than steel and lighter than wood floated through the air. Everywhere there was a richness and a beauty to the world that had been harsh and crude and dull.

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The secret of all this change lay with the chemist, the man who for centuries had toiled in the laboratory with his tubes and his furnaces, his vapors and his smokes. He discovered facts; he applied them and changed the world. No single profession ever gave man so much. Intellectually he enriched life, for he gave men truth; economically he enriched life, for his knowledge nourished the industries; physically he enriched life, for medicine and chemistry marched hand in hand; esthetically he enriched life, for he learned to beautify things.

The intellectual advance came first, for man sought for truth before he knew what truth would be. Step by step, sometimes by accident and sometimes by design, the chemist clutched small facts and began to piece them together until he could see where he was and where he wanted to go. Perhaps the discovery of sulfuric acid—which led to the finding of nitric and hydrochloric acids—helped most; but each successive find was employed in experimenting for other finds. The discoveries came slowly, but they came steadily. Mysticism crumbled: the elements were separated and defined, and men knew that the search for gold was a futile one. Moreover, the elements were arranged and measured and studied; it became apparent that they could be grouped, that each group had certain similarities and some groups were more complete than others. Perhaps this meant that there were elements yet undiscovered; if so, these were akin to those already known in that group. Working along these lines, and building up a vast technical structure by logical experimentation,

the chemist advanced in his craft. He learned to weigh and measure the atoms and the molecules; he began to understand the laws of structure; he began to classify the compounds that could be formed; he began to analyze the air. Not in a year, not in a hundred years, but by centuries of collection and classification of facts he made a brilliant spotlight that cut a wide swath in the darkness that was ignorance. He deepened the knowledge of men; he emancipated truth; he provided a healthy stimulus for the philosophies of the races; he interpreted nature through the medium of the test tube. Fundamentally, then, the chemist enriched life intellectually.

But all this knowledge was not merely a thing to be known. The chemist was quick to find that his science had practical applications. Often necessity showed the way, as in the case of France, when a war cut off her supply of sodium-carbonate-bearing plants from the salt marshes of Spain. The great glass factories faced a crisis; but Le Blanc, a chemist, by the use of sulfuric acid, learned to make sodium carbonate from common salt. The process that France invented in her extremity spread to England and later became a large and powerful industry. The sodium carbonate was treated with cheap slaked lime and resulted in caustic soda; the soap industry was stimulated and advanced. Glass and soap! Two common commodities that have enormously enriched life for mankind.

And, on the whole, when one comprehensively reviews the applications of chemistry in the service of mankind, it is to these little things that life is indebted. Light, soap, heat, medicine, inks, glues, metals, explosives—we live the more pleasurably because of them. Chemistry alone made progress of this kind possible. Without sulfuric acid, nitric and hydrochloric acid, other means would have to be found to purify gasoline and lubricating oils; there would be no railroads, automobiles, telephones, reënforced concrete, because the metals could not be blasted from the earth without the explosives that the acids help to produce. The textile industries would be crippled; tin cans, paper, galvanized iron, quick-acting phosphates for fertilizers, dyestuffs, celluloid, many medicines—none of these would have materialized.

The chemist found that by means of an electric current he could split a solution of salt into the elements of sodium and chlorine. The soap industry stepped forward again; the world learned the process of mercerizing, of manufacturing artificial silk, and the making of dynamite. The cotton industries trebled their speed of production, for chlorine bleached quickly and excellently. It even purified water.

Carborundum, an artificial abrasive of terrific hardness, was discovered. It was evident that it would change the art of grinding, but it was too expensive. The chemist who produced it did more: he found out cheaper means of producing it; and the price fell from eighty dollars to fifteen cents

a pound! The results were manifold. From victrola needles to locomotives, the new abrasive extended in scope and possibilities. It surfaced and beveled glass; it changed the processes of working marble and granite and onyx; it polished jade, hulled rice, finished fine leather, made fountain pens, ball bearings, harvesters, steel crank-pins, spindles, and wearing parts of machinery that could not be turned upon a lathe. The mechanical perfection of the automobile was made possible by the carborundum grinding wheel: it gave such a delicate accuracy to machine parts that a permanent film of oil was possible, resulting in low friction and long life.

From such organic growths as sugar cane, corn, potatoes, and beets the chemist derived alcohol. Hundreds of thousands of applications were found; each and every one contributed to the enrichment of life. Guncotton was made, and many things came from this nitrocellulose industry: brushes, combs, pin trays, billiard balls, buttons, mirrors, napkin rings. Food preservatives were made from alcohol; and it was found that oranges ripened quickly when in contact with ethylene gas. Cosmetics, liquid soaps, shaving creams, tooth pastes, deodorants, linoleum, inks, pencils, glues, paints, steel pens, and rubber goods demanded it. It bettered motor fuels; it made possible the fabric for airplane wings; it gave the pilot non-shattering goggles and the motorist an unbreakable windshield; it gave the photographer his film.

Man was making cloth from cotton, but he was throwing away the seeds. The chemist turned to the industry. From the rejected seeds he made washing powders, roofing tar, dyestuffs, paint, soap, feed for animals, yarns, writing paper, rope, carpets, fertilizer, and oils of all kinds. He saved millions of dollars that had been regularly going to waste.

From coal he extracted every tiny ounce of possible good. Every gas and vapor he turned to account. Perfumes, aspirin, flavoring, tar, illuminating gas, fertilizers, and a long list of brightly colored dyes came from what had before been only a dirty fuel. There was, indeed, no industry in which the chemist did not in some way work for the betterment of production and the enrichment of life. His knowledge of the purity of the materials of construction, for instance, assisted wherever buildings rose from the ground. He advanced manufacture and gave industry a new and throbbing heart with an abundance of rich red blood.

By the right catalyst Haber discovered fixation of nitrogen; by the right catalyst the hydrogenation of fats was made possible; the right catalyst speeded up the production of the vastly valuable sulfuric acid; the right catalyst showed that acetic acid could be made in great quantities from acetylene, a cheap and plentiful substance; and by the right catalyst astute Germans showed that pure wood alcohol could be made from water gas and steam. It was the chemist who pointed out these right catalysts.

Encyclopedias could be filled by a mere enumeration of the things the

chemist did for the world along similar lines. In every branch of commerce, industry, and art he made his presence known. From scientific refrigeration, which made possible the transportation of highly destructible foods, to the turning of casein into such things as glue, plastic materials, celluloid, and rubber, which alone saved millions of dollars, the chemist has revolutionized and bettered. The value, for instance, of modern lubricants, Portland cement, soap, dynamite, or glass alone cannot be estimated. The world would be crippled without them.

And so by his elimination of wastes and his utilization of hitherto useless materials the chemist has affected very profoundly the economic side of the world. The financial and the industrial are one indivisible unit, and the majority of the lesser institutions of the world progress or stand still in the same proportion that the financial and the industrial institutions function. And when wealth through industry means better social, educational, cultural, and physical life for the people affected, and when it is to the chemist that we must attribute much of the world's industrial advance, it cannot be well denied that economically the chemist has been a dynamic factor in the enrichment of life.

Physically, the chemist has enriched life; for medicine and chemistry have ever been kindred sciences, and it is through chemical mediums that medicine has been able to interpret and remedy bodily miseries. From alcohol alone came over four thousand very valuable medicines; three of these—antipyrin, salvarsan, and insulin—by themselves have erected a huge barrier against disease and helped wipe out afflictions that have been scourges for centuries. How incalculably anesthetics have enriched life by the alleviation of pain will never be estimated; billions of humans yet unborn will find that life has been made easier for those who must pass under the surgeon's knife. From the curing of deep-seated wounds by means of hypochlorous acid, to the sanitation of the water-purification plants in the great cities, the chemist has given man a longer and less harsh span of years.

How the chemist has featured in the esthetic scheme of things has ever been unappreciated. As a cherished inheritance from the past man has a desire for color in his surroundings. Life would be a dreary waste without it; there would be no subtle music that could be enjoyed by the eye. It is useless to enumerate specific things on which the chemist has lavished the endowment of beauty; for they are universally manifold. The ugliness and crudities of man-made things have been glossed-over: the desire for beauty has been fulfilled. And life, subsequently, has been enriched in the esthetic sense—an enrichment which cannot be instantly appreciated, but without which existence would lose all glamor and glow.

It is but natural that the chemist should be the most vital factor behind all of these changes, for he deals with the structure of matter, and matter

embraces all things. A nation may be judged by the excellence of its chemists; for chemical progress has come to symbolize the advancement of truth, the march of civilization, the enrichment of life. The chemist has enriched life economically; the chemist has enriched life intellectually; the chemist has enriched life physically; the chemist has enriched life culturally. . . . . .

And still the man behind the test tube toils on. New and more lofty peaks of achievement tower before him. The realization that the elements are not, after all, the fundamental bricks out of which matter is made has opened new vistas. He is like a musician at the console of a vast universal organ; so far he has touched only a few of the keys. The acclamation of the multitude has never been his, despite the fact that he has so greatly contributed to civilization and the enrichment of the lot of his fellow beings. But chemists are odd mortals, and have rewards of their own. Old Johann Joachim Becher—a true member of the brotherhood—spoke for them all when he said: "The chymists are a strange class of mortals impelled by an almost insane impulse to seek their pleasure among smoke and vapor, soot and flame, poisons and poverty, yet among all these evils I seem to live so sweetly that I may die if I would change places with the Persian king."

Collection of Czechoslovak Chemical Communications. The first two numbers of the *Collection of Czechoslovak Chemical Communications*, and a new monthly journal published in Prague at 170 kc (26 Swiss francs, or £1 to English subscribers), contain articles embracing the whole subject of pure chemistry.

In the January, 1929, issue there are the following:

On the Complex Oxalates of Scandium. By PROF. J. STERBA-BÖHM AND S. SKRAMOVSKY.

The Deposition of Radium and Other Alkaline Earth Metals at the Dropping Mercury Cathode. By J. HEYROVSKY AND S. BEREZICKY.

Rhamnoconvolvulic Acid. By E. VOTOCEK AND V. PRELOG.

Those in the February issue are:

The Reaction of Cupric Salts with Thiosulfate. By J. HARRIS AND V. HOVORKA.

The Titration of Thallous Salts by Permanganate in Hydrochloric Acid Solutions. By A. JILEK AND J. LUKAS.

The Formation of Acid Lithium Aluminate. By V. PROCIV.

On the Methylated Nitro-Naphthylamines. By V. VESELY AND A. VOJTECH.

Alcoylated Pyrrolones. The Synthesis of Gamma-Ketonic and Fatty Acids. By R. LUKES.

The journal, which is published in French and English, is intended to disseminate the discoveries and results of researches carried out in the laboratories of the Czechoslovak universities and technical colleges. The editors are Dr. J. Heyrovsky, Prof. of Physical Chemistry, Charles University, Albertov, Prague; and Dr. E. Votocek, Prof. of Organic Chemistry, The Czech Polytechnical Institute, Trojanova 13, Prague. —*Chem. News*, **138**, 157 (Mar. 8, 1929).

INSECTICIDES*

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Intensive agriculture, like so many advances of civilization, brought with it its attendant evils. As land was permanently cultivated, the food for insects increased and their natural enemies became proportionately fewer; consequently, man found it necessary to combat these parasitic enemies by devices of his own.

CHARLOTTE NISSLEY

Originally, insecticides were chosen because of offensiveness to the senses, with little regard to other factors now recognized as important. Natural conditions, such as light, moisture, temperature, the atmospheric gases, and compounds secreted by the plant are all worthy of consideration. Of primary importance is a knowledge of the living habits of the insect. Leaf-chewing insects are combated by poisons applied to their food, while those insects which pierce the leaves and bark and extract juices below the surface must be fought with contact poisons, *i. e.*, substances which destroy the insects by suffocating them or by having a corrosive effect upon their bodies. Against all insects the most effective procedure is the destruction of the eggs, accomplished by a corrosive substance applied to the dormant plants. Frequently, the application of a detergent wash in winter is a useful adjunct to insecticides, for it facilitates the reaching of the eggs by the liquid and reduces the number of crevices in which insects may deposit eggs. The effect upon the plant itself must necessarily be considered, for experimentation proves that many insecticides most effective against insects are likewise injurious to the plant itself. Obviously, the use of such an insecticide

* Prize-winning college essay, 1928–29.

would defeat its own purpose. The essentials of a good insecticide, then, are cheapness, effectiveness, non-injury to the plant, and adherence.

In the past, most insecticides were found by accident. Recently, chemistry has entered more into the field, and the battle is now one of chemical warfare. The manufacture of insecticides is a distinct industry, and one of increasing commercial importance.

One of the oldest, and at the same time most common, insecticides consists of sulfur or sulfur compounds. Sulfur is one of the few insecticides applied as a solid. It is used on hops for the destruction of mildew and red spider. Its action is rather uncertain, but may be due to its slight volatility, for it is most effective in the presence of moisture. Sometimes it is mixed with water and applied as a wash, the action of which appears partly mechanical, for the sulfur deposited on trees glues the San José scale—against which it is used—to the bark and prevents egress of the young. A mixture of lime and sulfur with water is used for aphis, mites, and red spider in preference to sulfur itself. This mixture possesses the advantage of being also a fungicide. Calcium and potassium sulfides are also used, the latter being preferable because it may be mixed with soft soap without decomposition.

Arsenic is the chief ingredient of many of the most powerful insecticides. These insecticides are called arsenicals. Paris green, a compound of arsenic and copper acetate, is much used, although it may cause injury to the foliage by scorching the leaves. Its use against the potato beetle was really the start of the insecticide industry in America. The canker worm and codling moth are also combated by it with different degrees of success. Arsenate of lead is used against the Gypsy moth, elm leaf beetle, grape worm, and codling moth. It is sold in the form of a paste, sometimes mixed with other materials, and is preferable to the home-made product, owing to the small proportion of acetic acid which it contains. Calcium arsenate was used against the boll weevil, which in 1894 almost covered the cotton areas.

Nicotine is perhaps the most important of the plant insecticides. The use of nicotine dust is of recent origin. The dust which volatilizes the largest percentage of nicotine within a given time is most effective.

There is an increasing tendency to use flowers as a source of dusting powders. In the case of Pyrethrum, the dusting powder is prepared by extracting powdered flowers with mineral oil. A dust of 20% Derris root is found to control certain lice, and other applications containing Derris are toxic to caterpillars and other pests. Hellebore, obtained from root-stock and roots of the white hellebore plant, is found effective against caterpillars on gooseberries, etc. Its effect is probably due both to its poisoning the food of the caterpillar and to its contact with their bodies. As it is less poisonous than arsenicals it may be safely used shortly before the ripening of the fruit.

Another method of combating insects is by the use of fumigants, which, although especially adapted for indoor use, may be used out of doors as well. Of these, one of the foremost is hydrocyanic acid gas. As it is one of the most deadly toxic gases known, care must be taken in its use. Carbon disulfide has been extensively used, but its high explosive properties render it dangerous in other than skilled hands.

An example of the type of experimentation with new compounds now being carried on by chemists is seen in the field of fluosilicates, which has offered indications of success in the past four years. Calcium fluosilicate, which has been found to be among the most successful, is a by-product of the volatilization method of treating phosphate rock in the manufacture of phosphoric acid. As it is insoluble, it may safely be used without injury to foliage. By experimentation, it has been found effective against the flea beetles, beetles attacking soy beans, and even the striped cucumber beetle, upon which arsenicals have no effect. The success of fluosilicates is in this instance probably due to the beetle's habit of cleaning its feet in its mouth. In numerous other cases, fluosilicates have been tried successfully, and their advantages over arsenicals seem to consist in controlling numerous insects resistant to arsenicals, and in being far less poisonous to man, yet fully as toxic to most insects.

Improvements in the application of insecticides have been accomplished. The airplane has proved its use in the dusting of extensive infested areas, and the coöperation of the government is seen in the authorization of a large sum for experimentation in airplane dusting as a control for the sugar cane moth borer. The airplane is particularly indispensable in dusting large forest tracts, etc., which it would be almost impossible to reach by ordinary methods of insecticide application. Another method, resembling the "smoke candles" of war days, and developed by war technicians, consists in setting in the ground or carrying on poles through an infected area arsenical smokes, which fill the air with a white fog. After this has settled, the foliage is found to be coated with arsenic. This method would be cheap and rapid, but as yet reports of its effectiveness are not complete.

Rather than becoming less, the interest in insecticides is increasing, as people are impressed by reports of the tremendous economic loss in our own country due to insect invasions. The loss extends to growing cereals, hay and forage crops, tobacco, truck crops, cotton, fruits, forest and shade trees, live stock and stored products. In many cases the astounding proportion of one-tenth of the total crop produced is ravaged by destructive insects. Although modern agricultural methods and mechanical means may play their part, the ultimate eradication of many pests will rest upon the wise use of insecticides.

The fight started in 1924 against the Mexican boll-weevil may serve as

evidence of the extensive work necessary to combat even one variety of insect. During the experiment, 1000 poisons and 2500 of their compounds were tested for relative toxicity against the weevil. The most promising of the substances were subjected to a further test as to their toxicity on the cotton plant itself. After a long series of tests, covering a period of three years, two substances stood out as possibilities in the control of the weevil. One was a special calcium arsenate, prepared by heating calcium carbonate and white arsenic in the presence of excess air at 650°C.; the other was sodium fluosilicate, a by-product in the manufacture of acid phosphate. Both are relatively cheap, easy to make from raw materials which are abundant, and show a toxicity equal to commercial calcium arsenate, which is more expensive. There are minor details to be improved, such as greater adhesion in the case of the fluosilicate, which indicate that the work of the chemist is by no means complete. As in all cases, the task of choosing a suitable insecticide is made more difficult by the conditions unique to the particular insect. In the case of the boll-weevil, many strong poisons were found useless because of their insolubility in the system of the weevil. Also, while adhesion is necessary, it must not be too great, for the destructive effect on the weevil is due to its habit of picking up the insecticide on its moist snout. The question of attractants and repellents likewise opens an interesting field of speculation. The weevil was found to be affected more readily by mixtures in honey than in other sweets, possibly due to a preference for the former taste. An investigation is also being carried on to determine if there are not some substances that might be successful as repellents or irritants that would induce the weevil to fly.

The whole field of insecticides, like so many phases of chemistry, is not stationary, for at any time substances now in common use may be replaced by others more effective for all purposes. Many substances are now claiming important places for the first time. Carbon tetrachloride is used against the hook-worm, paradichlorobenzene against the peach borer, creosote oil to preserve timbers and formaldehyde in seed treatment.

The chemist has as yet to find a more completely desirable insecticide—one as "harmless to the foliage as arsenate of lead, and as deadly to the insect as Paris Green and nicotine, as cheap as lime sulfur, and no more harmful to the soil than lime sulfur or nicotine." This represents a large order, but even when it is filled, the work will not cease, for indications are already seen of preventive measures in the field. In Germany a laboratory has been established to combat the European corn borer, although corn is not now raised extensively in that country. These far-seeing people propose to start its production on a large scale, and intend to get a "jump ahead" of the enemy! Certainly others will follow this example, and perhaps in the distant future the use of insecticides may be largely a preventive measure rather than a cure.

Though the casual observer may readily realize the tremendous importance of the subject of insecticides to the farmer, nurseryman, fruit producer or any one whose work deals primarily with the soil and the crops produced from it, he may not at once see that, less directly, it actually concerns each of us. Yet such is the case, for the consumer must ultimately bear the loss suffered by the agriculturist in planting, cultivating, and harvesting crops of which a large proportion is destroyed by insects at some time before it reaches the consumer. Hence, whether we live in town or country, whether we are versed in agriculture or must confess to a deplorable ignorance of it, whether we pluck our dinner fresh from the garden or hastily remove it from a tin can, we cannot escape the results of these ever vigilant enemies of man. But the outlook is not wholly gloomy, for, thanks to the chemist in his laboratory, we need not stand in such great dread of the invasion of these enemies, but can look forward to the time when man may have a decided advantage in this centuries-old battle.

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Radium Committee Plans Methods of Investigation. The committee recently appointed by Surgeon-General H. S. Cumming of the U. S. Public Health Service to study the problem of radium poisoning occurring in New Jersey factories has recently met to consider plans for beginning the study. All details of method and procedure were discussed and decided upon. According to present plans the study will be finished about July 1st.

Radium poisoning occurred among employees of luminous watch dial factories in New Jersey, causing illness and death in some cases. While the poisoning cases occurred among the girls engaged in painting the dials, all employees were found to be exposed to radium in varying degree. The present study is to determine among other things just how much radium is absorbed by the bodies of the workers, how this will affect their health, and what safeguards may be taken. About 200 persons are engaged in the industry. Detailed physical examinations of these individuals will be made. The committee consists of public health and other physicians, including members of medical school faculties.—*Science Service*

THE RELATION OF CHEMISTRY TO NATIONAL DEFENSE*

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Science is a culture, the most generous culture we possess. There is no "science for science's sake." No matter how remote the "somehow good" of scientific investigation and discovery may appear to the near-sighted skeptic, its ultimate application exists, to be disclosed in good time and incorporated into our increasingly elaborate plan of living. More than six hundred years have elapsed since Roger Bacon, in an unprecedented manner, burned the works of Aristotle, thus abjuring all traditions held by the great scholastics concerning the nature of things, and set about with hands and brain to discover on his own responsibility something of the world we live in. Science has been learning ever since, and some of the marvelous conjectures of Bacon are only today finding realization at the hands of modern science. There is all reason to believe that science will go on learning, and our minds are almost overpowered by the contemplation of the golden millenium to which the hopes and visions of present-day scientists may lead.

MARY P. WOOLVERTON

The great secret of science lies in its applicability, its generosity, its power of realization. As science receives, it gives; as it learns, it applies. Science does not hoard its benefits, in the miserly fashion of most cultures, for the edification of its most loyal disciples; nor does it raise itself above the masses with a fine contempt for their inability to appreciate its deeper meanings. With a magnificent generosity, science offers its dearest findings to the world at large, where they are received, translated into terms of their greatest good, honored with a passing wonder by the most thoughtful, and henceforth accepted as a matter of course. But science is above ingratitude and never falters in its noble magnanimity.

* Prize-winning college essay, 1928–29.

We have been speaking of science in its largest sense. When we come to consider the separate sciences, we find that the one which has reached its greatest development, the one which has gone far beyond scholarly surmise and has bestowed its material benefits most lavishly on mankind is chemistry. For a long time chemistry has played an increasingly important rôle in raising our plane of living higher and higher. By its discoveries our lives and property are safeguarded, our day to day existence made infinitely more comfortable and enjoyable. There is one field, however, in which chemistry is only just beginning its brilliantly promising career, a field which this great science bids fair to monopolize in time, the field of national defense.

The military strength of a country has always been reckoned in terms of its resources and the actual physical strength of its army. Warfare has been the pitting of the strength of men against men. Chemistry is teaching us to pit the strength of atom against atom. Chemistry is offering a place for brain power as a substitute for brute strength in national defense. Chemistry is opening up new resources to the nation and increasing the efficiency of old resources. Chemistry, in short, is revolutionizing warfare and national defense.

The term "chemical warfare" did not come into use until the late war, when lethal gases were recognized as essentially chemical substances. As a matter of strict truth, warfare has been chemical in a varying degree from the time when the first imperfect mixtures of saltpeter, sulfur, and charcoal were used in the form of crude hand-grenades to attack the hitherto unassailable old fortresses of Medieval Europe. Gunpowder was first used in Europe during the thirteenth century, and its invention by Roger Bacon, Friar Schwartz, the Chinese or whom you will, marks the first step in the development of explosives. The subsequent steps, the discovery of basic explosive materials, the synthesis of valuable compounds, have probably all been made by chemists, working obscurely in their laboratories with little thought of revolutionizing warfare or of providing man with a more efficient weapon to use in wiping his enemy from the face of the earth.

Gunpowder was first used in grenades, then as a powder, and finally, in a more convenient granular form. The early gunpowder emitted so much smoke that the position of the firer was dangerously advertised to the enemy. In addition, the action of the powder was so uncertain that it became a question whether one would hit his target or blow himself to small bits in the attempt.

The first marked improvement in gunpowder came in 1860 as a result of the work of General Rodman of the United States Army, who discovered the principle of progressive combustion of powder. He found that, by compressing finely divided powder into large grains and thus increasing its

density, the pressure resulting from its burning could be controlled. Following this discovery, gunpowder was manufactured in grains suitable for particular guns, and shaped and perforated in such a way as to control the velocity of combustion.

The basis for smokeless powder, guncotton, was discovered by Schoenbein in 1845. Guncotton is made by treating wood pulp or cotton with nitric acid in the presence of sulfuric acid. The product looks like common cotton. It is dissolved in ether-alcohol or acetone, molded and cut into grains of the desired size. In 1865 the first smokeless powder was introduced. This powder consisted of wood, nitrated and treated with potassium nitrate. However, smokeless powder was not used for military purposes until 1886 when a French engineer, Vieille, made use of nitro-cotton in making smokeless powder. Later the powder was further improved by the addition of stabilizers. Smokeless powder has almost entirely replaced the old black powder for military purposes.

Before going further into the subject of explosives it might be well to say something of the most important element of all explosives, nitrogen. Nitrogen is known as an "inert" element, from the fact that it is very hard to get into combination with other elements. Its value in explosive materials lies in its eagerness to get out of combination as quickly as possible. When an explosive compound is disturbed violently enough the shock spreads throughout the mass, the hydrogen and carbon atoms undergo very rapid combustion, and in a flash all the atoms are rushing this way and that. The result is a violent explosion, sometimes sufficient to move a heavy cannon ball many miles.

In 1846, a year after the discovery of guncotton, nitroglycerin was discovered by an Italian chemist, Sobrero. Dynamite is made by mixing the liquid nitroglycerin with something which will soak it up, and then molding the mixture into sticks. Guncotton must be molded by mixing it with some liquid. In 1888 Alfred Nobel, a Swedish chemist, thought of combining the two, of soaking up nitroglycerin with guncotton to form a double explosive which possessed many times the violence of explosives formerly used. Nobel's invention is called "cordite," and is composed of nitroglycerin and nitrocellulose with a little mineral jelly.

Besides cordite there are several other high explosives, the newest and probably best known being trinitrotoluol, or TNT. TNT is, in many ways, the best high explosive. It does not react with the metal of the containers and is not sensitive to ordinary shocks. It melts at a low temperature, and can be poured easily into shells. When it is detonated by a rather violent shock it explodes with terrific force.

The use of high explosives has destroyed the usefulness of elaborately strengthened fortresses and given birth to a new type of fighting, trench warfare. During the World War, the Allies did not succeed in breaking

the German line until they were able to blow the enemy out of their entrenchments with great shells loaded with high explosives.

The World War witnessed the introduction of a weapon capable of penetrating entrenchments where shot and shell do not go; a weapon swift, sure, and deadly—lethal or "poison" gases. The first attack with poison gas was made by the Germans at Ypres in 1915, an attack which produced a wave of horror throughout the whole world. Tales were told of a horrible death, of writhing agony, purpled faces, of hideous gasping and choking. But if chemistry was at fault in supplying men with so deadly a weapon, it was redeemingly swift in providing a defense against lethal gas. Gas masks were made and perfected to their present form. The modern gas mask is provided with materials to filter out any smoke, no matter how fine its state of subdivision. The compartments of the cannister are filled with charcoal for absorption of gases and chemicals which undergo reaction with the poison, reducing it to a quite harmless state.

There are other gases, less deadly, which cause only temporary disablement. Tear gases, or lachrymators, produce a copious flow of tears, blinding the victim and rendering him unfit for military service for several hours. The same effect is created with sneeze gases, or sternutators, which cause violent fits of sneezing or laughing. These gases do not leave permanent ill effects.

Another gas whose value in national defense has not yet been tested to the fullest extent is non-toxic smoke. This is produced in three ways: by smoke candles, which produce dense black clouds, by the ejection of titanium tetrachloride under pressure, or by the use of white phosphorus bombs. A smoke screen thrown up by one of these means destroys visibility entirely. Troops of soldiers may proceed protected by such a screen. Battleships may be completely hidden. The greatest possibilities of smoke screens remain to be seen.

Chemistry has made many important contributions to air service by providing chemically controlled fuels which will undergo combustion in spite of altitude; by producing strong-light alloys for the construction of airships; by formulating "dopes" which will keep airplane wings taut under all conditions. Chemistry has produced the gases used in balloons and dirigibles—helium and hydrogen—and reduced their cost to a reasonable point. Aircraft is not strictly an exponent of chemical research, but it owes much of its rapid progress to chemistry.

The contributions of chemistry to health and sanitation are incalculable and can only receive the barest mention in an article such as this. By a correct application of chemical knowledge, the purity of all food and water supplies can be assured. Synthetic organic chemistry has made possible adequate care for the wounded. Chemistry has supplied anesthetics, antiseptics, and germicides in large quantities and of the high-

est quality. Painless surgery owes much of its present efficiency to chemistry.

Not only does chemistry assure the purity of food but it also makes the food supply sufficient. In time of war, food production must be increased, unnecessary waste eliminated and industry conducted on a more efficient and economical plane. Substitutes must be found for any commodity which is scarce, and the whole nation must learn to practice economy. In such cases chemistry becomes of the highest importance, showing the way to increase resources and to use them to the greatest possible advantage.

Even from so superficial a survey as this, it is clear that chemistry is a vital factor in national defense, and that its importance as such is rapidly increasing. The chemist's knowledge of the nature and action of matter is becoming the great principle underlying our methods of attack and defense. When we consider that chemistry is only just beginning its work in the field of national defense, we catch a vision of the great future which lies before it as the protector of nations.

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British Science Meeting to Travel in South Africa. The 1929 Meeting of the British Association for the Advancement of Science will be a somewhat unique combination of a scientific assembly and a scientific tour, in that it will be held in two widely separated cities, Capetown and Johannesburg, and the two-day railway journey northward will come as a break in the middle of the program.

The visiting scientists from Britain and other countries of the northern hemisphere will land in Capetown on the morning of July 22nd, and the meetings there will begin on the same day. Then, on July 28th and 29th, sections of the Association will start for Johannesburg by rail, arriving there on July 30th and 31st. At Johannesburg the meetings will continue until August 3rd. In addition to the long but interesting train journey between the two meeting places, there will be a number of systematic tours to points of scientific and scenic interest, including the famous gold fields and diamond mines.

A third city, Pretoria, will participate in the scientific activities of the season. The Fifteenth International Geological Congress is to be held there from July 29th to August 7th. The Pan-African Agricultural and Veterinary Congress will also meet in Pretoria. Since this city is only about an hour's run from Johannesburg, delegates to the British Association meeting will have no difficulty in attending such sessions as they wish to visit at Pretoria.

The British Association for the Advancement of Science has held one previous meeting in South Africa. This took place in 1905.—*Science Service*

DISINFECTION AND THE PRESERVATION OF FOOD IN THE FARM HOME*

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From the beginning of time, people have lived in the country: first as hunters and fishermen, later as herdsmen, and still later as tillers of the soil. All established homes, after a fashion, but it is only in the past century that the farm home has become the ideal place it is today. It is largely due to the development of chemistry along all lines, but especially to the intensive study which chemists have given to sanitary measures, prevention of disease, and the general welfare of the people as a whole that the rural home has reached this high pinnacle of perfection.

ROSALIE O'HERRON

If there is doubt in the mind of any one as to the veracity of this statement, he has but to look into the homes of an African village, and see the squalid one-room grass huts in which the whole family must live, eat, and sleep. Not only the family finds shelter here, but also the pigs, chickens, and cow, if they are so fortunate as to possess any. The floors are made of earth, the only openings are a low doorway and a hole in the roof which serves as an outlet for the smoke from the open fire. When a meal is prepared, the family gathers in a circle, a large pot containing the food is placed in the center and each member of the group helps himself, without the aid of fork or spoon. Because of the filth and dirt in these homes disease is prevalent, severe epidemics are frequent, and many deaths follow.

The picture of our modern American farm homes stands out, a sharp contrast. Here are large well-built houses of wood or brick, whose rooms are filled with sunlight and fresh, pure air. The floors are polished; the walls are smooth and beautiful; the kitchen utensils are of the best ma-

* Prize-winning college essay, 1928–29.

terials; electric lights, furnace heat and up-to-date sewage disposal eliminate all kinds of dirt. As a result, the home is sanitary in every respect; disease germs have little chance to grow and epidemics are quite rare.

Sanitation in a farm home is similar, in many ways, to that of the village or city home, but the farmer has some special conditions to meet and problems to solve with which the man who lives in the city is not confronted. An abundant supply of pure water is a most important agency contributing to the needs of mankind. As water falls from the skies in the form of rain, snow, or hail, it may be said from the dietetic point of view to be pure;[1] but it gathers dust particles and carbonic acid as it falls through the air, and as soon as it reaches the ground, it begins to act as a solvent for many of the chemical elements found in the soil. Both inorganic and organic impurities are introduced in this way. The inorganic matters such as calcium, iron, and magnesium are not injurious to health if present in moderate amounts. But with the organic impurities it is quite different. While much of the organic impurity is due to decaying vegetable matter which is not known to be definitely harmful as a constituent of drinking water,[2] these nitrogenous organic bacteria are significant because they point to a probable contamination of the water by the animal excreta, or pathogenic bacteria. Such living organism may reach the water by way of surface water from land supplied with manure or from sewage waste.

The different states have given much aid in securing pure water supplies. They carry on work in research laboratories, and will examine, free of charge, any samples of water sent to them in specially provided containers. Water purification has reached a high standard for cities and towns which use a central supply system. Here the water is purified by use of a filtration system, or more often by the addition of chlorine;[3] but little can be done along this line in the country. Therefore, it is advisable to use only water from wells which are driven deep into the ground, or wells which are lined with waterproof cement. Care must be taken to see that the well has a tight, dirt-proof cover. When it becomes known that a well has become contaminated, this well must be thoroughly cleaned and protected from surface drainage and other sources of infection, or it must be abandoned for domestic use. If water on the farm is infected with typhoid germs or other harmful bacteria the only way to be sure to kill the germs in the drinking water is to boil all that is used for that purpose.

Sewage disposal has a direct relation to the family water supply and home sanitation. The old method of throwing all water and other waste material from the kitchen out the back door was very unsanitary. This has

[1] Tilden, Wm. A., "Chemical Discovery and Invention in the Twentieth Century," E. P. Dutton and Co., New York City, 5th Ed., **1926,** p. 254.

[2] *Ibid.*, pp. 254–5.

[3] Hopkins, B. Smith, "General Chemistry for Colleges," **1927,** p. 113.

passed away along with the use of the old open privy, not protected from flies or disinfected in any way. Complete water systems have been installed where the drainage from the kitchen and inside toilets empty into cesspools or septic tanks, and the organic matter in the sewage is entirely destroyed. All practical systems of sewage disposal for the farm depend upon the action of bacteria for their efficiency. In the septic tank the anaerobic bacteria break up the organic matter and transform it into dissolved and gaseous matter which passes out with the tank effluent. This effluent may empty into water not used for domestic purposes or drain into filter beds.[4]

But the world would never have known of these sanitary measures if it had not been for chemists and their untiring research work. "Chemistry and indeed all science works in no more difficult field than that pertaining to health and disease."[5]

"Washing for its sanitary or aesthetic value is a comparatively recent development."[6] Water alone is not sufficient to remove many kinds of dirt. It is only with the use of soaps and scouring powders that all dirt can be removed. The older inhabitants made a soap from their grease and meat refuse combined with a lye they secured by leaching wood ashes. This combination produced a soap which worked very well for scrubbing and ordinary laundry purposes. Even today the farmer's wife makes soap by using commercial lye (sodium hydroxide) and waste grease. The manufacturers and their chemists have prepared soaps of all kinds for all purposes. There is the soap which is used for general house work and the laundry; scouring powder which contains a soap element along with the scouring compound; soap that will float; pretty, scented soap; and soap which has been medicated by the addition of phenol, cresol, or similar disinfectant.[7]

Because many articles, such as fine wools or silks, are injured by the use of water, the chemists have substituted dry cleaning reagents: gasoline, naphtha, ether, alcohol, benzene, and other organic solvents. These are inflammable and dangerous to use in a closed room but carbon tetrachloride and chloroform are not; therefore, they are perfectly safe to use in the house.[8] Closely allied with the soaps and dry cleaning reagents are the mechanical devices used in cleaning, such as scrub brushes, chore balls, brooms, vacuum cleaners, dustless mops, and dust cloths which have been chemically treated to prevent their scattering dust while in use. There is

[4] *International Encyclopedia*, 1923—"Sewage Disposal."

[5] Howe, Harrison E., "Chemistry in the World's Work," D. Van Nostrand Co., Inc., New York City, 1926.

[6] Garard, Ira D., "Applied Chemistry," The Macmillan Co., New York City, 1924, p. 274.

[7] *Ibid.*, p. 279.

[8] *Ibid.*, p. 279.

also a whole list of brushes for personal hygiene. By the use of all these articles for cleaning, the farmer's wife has been able to make her home one of the cleanest and most healthful in America.

Chemistry has given her another tremendous help through the gift of paints and varnishes. Paints are made by grinding natural ores, or ores chemically produced in linseed oil. This mixture is then thinned with turpentine or mineral spirits, and a dryer added to accelerate the drying tendency of the oil.[9] "The production of varnishes has sent the chemist to all parts of the world for raw materials."[10] Garard has said, "The purpose of painting is twofold; to preserve the material treated and to beautify it."[11] But paint and varnish also serve by making the home more hygienic. Although the individual elements contained in paints and varnishes do not have antiseptic powers, in their several combinations they will kill all germs which they cover by smothering them. Paints and varnishes also make the housewife's daily and weekly cleaning task much easier. Soiled spots will wash from waterproof paints quite readily; dust and dirt will not be absorbed by the woodwork protected by paint. If a room becomes too dusty and dirty it is a simple task to repaint it and the result is a beautifully clean room.

The hardest fight, perhaps, that people of rural communities have to carry on is the one against house flies. The favorite breeding place of flies is horse manure;[12] filthy stables, barn-yards, and refuse piles hatch millions. The fly deposits its eggs in the manure and they hatch in twelve to twenty hours. The fly exists in the larva stage four to six days; after which the larvae leave the manure and enter the ground, sometimes boring six feet deep. It takes from ten to fourteen days for the eggs to hatch and develop into full-grown flies in warm weather.

The only possible way to eliminate flies is to dispose of manure promptly, to burn all garbage and kitchen waste, and to have sanitary disposal of human feces.[13] Along with these sanitary measures it is necessary to kill all adult flies. The importance of their destruction is easily recognized when scientists state that flies will carry typhoid germs twenty-three days, and tuberculosis bacilli six days.[14] As a first precaution the farm house should be provided with tight screens over windows and doors; fly traps and poisons may be used and are quite effective; still more effective, however, are liquid sprays whose fumes are certain death. As a last resort, use the fly swatter, but the fly swatting is the poorest method of all

[9] Howe, Harrison E., *op. cit.*, p. 96.

[10] *Ibid.*, p. 97.

[11] Garard, Ira D., *op. cit.*, p. 349.

[12] Vedder, Edward B., "Sanitation for Medical Officers," Medical War Manual No. 1.

[13] Vedder, Edward B., *op. cit.*, p. 110.

[14] *Ibid.*, p. 111.

because its need proves that other methods are not being carried out efficiently.[15]

Every home should have a first-aid cabinet, where the necessary medicaments and dressings for sudden illness or injuries are kept. The possession of a cabinet of this kind is much more important in a farm home, miles away from a doctor or hospital, than it is in a city home where medical services can be secured in a few minutes' time. The cabinet should hold a good antiseptic liquid, a good salve, absorbent cotton, gauze bandages, and adhesive tape. Hydrogen peroxide was in common use as a disinfectant a few years ago, but this compound is quite unstable[16] and its use has been largely discontinued in favor of iodine and mercurochrome. Mercurochrome is an antiseptic which grew out of the World War, and it is now considered one of the best for first-aid purposes. Boric acid is a mild antiseptic used especially in the care of infants, but is also recommended by doctors for treating the eyes and ears and some kinds of wounds. Salve containing carbonic acid or zinc oxide is appreciated in dressing burns or bruises. Chemists have discovered or originated all these medicaments and have given them to the world with the hope that human suffering might be lessened.

The care and preservation of food, as it is carried on by the home makers of today, is very closely related to disinfection. "It was not until the biologist showed that decay was due to the action of living organisms that floated in the air,"[17] that fresh attention was directed toward promoting the knowledge of disinfectants.[18] While, "human food is drawn entirely, either directly or indirectly, from the vegetable life of the earth,"[19] "milk is the only substance intended primarily as food." It is a very common source of disease infection. Many people contract tuberculosis by using milk from infected cows, and typhoid epidemics are known to have originated in impure milk supplies. The danger of tuberculosis has been greatly reduced by the work of the Department of Agriculture; but it is the responsibility of each individual farmer to see that his cows are regularly tested. Each farmer is also responsible for the cleanliness and purity of his milk; everything directly or indirectly connected with the milk should be clean, and all vessels used should be sterilized. Hooded milk pails or those with side apertures[20] are the best to use. The heating of

[15] Vedder, Edward B., *op. cit.*, p. 111.

[16] Dakin and Dunham, "Handbook of Antiseptics," Macmillan Co., New York, **1917,** p. 5.

[17] Rideal, Samuel, "Disinfection and Preservation of Food," John Wiley & Sons, New York, **1903,** p. 4.

[18] *Ibid.*, p. 4.

[19] Garard, Ira. D., *op. cit.*, p. 233.

[20] Lane, Janet E., "Milk and Its Hygienic Relations," Longmans, Green & Co., New York, **1916,** pp. 274–5.

milk approximately to 100°C. acts as an efficient safeguard against disease by harmful organisms.[21] Since bacteria cannot multiply at low temperatures all milk should be quickly cooled and kept at 40–50°F.

The ancients discovered that food could be preserved by drying or salting. Early Egyptians knew how to use alum as a preservative and the smoking of meats and fish was practiced in the north at the dawn of history.[22] But early preservation of foods went little farther than the use of these methods, "until it was shown by the research of Pasteur and others that decay is due to the growth of low orders of micro-organisms.[23] It has also been proved that organisms do not flourish in the presence of sugar or salt.[24] The statement has been made that their antiseptic action is due to the ease with which bacteria give up a part of their constitutional elements to the concentrated solutions of these substances, and thus do not have the same capacity for reproduction.[25]

Nicholas Appert is the forerunner of modern canning and preserving. In 1804 he discovered that meat, vegetables, and fruits could be kept indefinitely if placed in carefully sealed receptacles and dipped in boiling water for one hour.[26] In 1810 he suggested the method of heating in steam and then sealing so that on cooling a vacuum was formed.[27] The chemistry of these processes was not well understood until explained by Pasteur, Tyndall, and others.[28]

From these beginnings have grown the methods which the farmer's wife uses in storing away meats, fruits, and vegetables for the use of her family during the whole year. In fact, the living conditions of the home itself are the direct result of the chemist's work.

[21] Lane, Janet E., "Milk and Its Hygienic Relations," p. 290.
[22] Rideal, Samuel, *op. cit.*, p. 409.
[23] Baily, E. H. S., "The Source, Chemistry, and Use of Food Products," p. 214.
[24] *Ibid.*, p. 214.
[25] *Ibid.*, p. 217.
[26] Rideal, Samuel, *op. cit.*, p. 29.
[27] Baily, E. H. S., *op. cit.*, p. 223.
[28] *Ibid.*

Humphry Davy Celebrations in Cornwall. Cornwall is preparing to celebrate the centenary of the death of one of its most distinguished sons, Sir Humphry Davy, the eminent chemist. He was born at Penzance, where on May 28th, the three learned societies of Cornwall, the Royal Institution, the Royal Geological Society, and the Royal Polytechnic, are meeting to do honor to his memory. A laurel wreath will be ceremonially placed on the Davy monument by Mr. J. C. Tregarthen, president of the Royal Institution of Cornwall, in the presence of Sir Humphry Davy Rolleston, a lineal descendant of the great chemist, and commemorative addresses will be given by Professor Ambrose Fleming, representing the Royal Institution of Great Britain, Dr. John Symons, president of the Royal Cornwall Geological Society, and others. There will also be an exhibition of Davy relics.—*Chem. Age*, **20**, 450 (May 11, 1929).

THE RELATION OF CHEMISTRY TO THE RUBBER INDUSTRY*

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Rubber has been known to the civilized world since the beginning of the sixteenth century. In those dim and misty years there was no chemistry to analyze and put to use this new substance which was collected from the caoutchouc tree by the South American Indians. It is entirely to the chemist's credit that this crude and then practically useless material has been brought through its earlier and doubtful stages of development to the vital position that it now holds in the ranking industries of the world.

H. DONALD BERGENER

The earliest mention of rubber is found in some old accounts of Spanish explorations, written about 1525 or 1530. Columbus is said to have found the natives of Santo Domingo playing with balls made from the gum of the caoutchouc tree. Pizzaro's soldiers, when they conquered Peru, adopted the native custom of smearing caoutchouc juice over their coats to make them waterproof.

The first practical use that was made of this new substance gave it its name. Magellan discovered in 1772 that it was unequalled for removing pencil marks from paper. A lump was sent over from France to Priestley, that eminent English chemist who discovered oxygen. He cut the lump into small pieces and distributed them among his friends telling them that the little cubes were "India rubbers."

The natives of Peru and Brazil had used rubber, or cauotchouc, for waterproof clothing, for shoes, and had also made jugs and bottles out of it. The articles were rather sticky and ill-smelling, especially in hot weather, and Europeans were averse to adopting them for this reason. It remained for the chemist, some centuries later, to discover and develop the method

* Prize-winning college essay, 1928–29.

whereby rubber could be made to withstand heat and cold. A Scotch manufacturer, Macintosh, made his name immortal by putting a layer of rubber between two cloths. Even this was not satisfactory and it was not until the year 1839 that rubber manufacture was made possible, when an American, Charles Goodyear, by his now-famous "lucky accident" discovered the means of making rubber articles that would not melt on a hot summer day and would not become as stiff as a board on a cold winter one.

The life of Goodyear is one of unfaltering courage and conviction. It was a life of poverty, of high hopes followed by many failures and bitter disappointments. A friend of his, Hayward, told Goodyear that it had been revealed to him in a dream that sulfur would harden rubber. For ten years Goodyear worked on the chance that this "dream" had something back of it. He met with little or no success. One day he happened to drop a piece of sulfur together with a piece of rubber, which he was holding in his hand, on a hot kitchen stove. The sulfur and rubber at once fused into a homogeneous mass. The secret was found, for the mass formed retained its properties in both heat and cold. When asked why he had persisted in his experiments in the face of such overwhelming odds and repeated failures, Goodyear replied: "I was encouraged in my efforts . . . . . by the reflection that that which is hidden and unknown and cannot be discovered by scientific research, will most likely be discovered by accident, if at all, and by the man who applies himself most persistently to the subject and is most observing of everything relating thereto."

Immediately after Goodyear's discovery rubber goods began to be manufactured on a large scale. Here was the field for the chemist. Some kinds of rubber were required to be soft and pliable, as in the manufacture of rubbers, boots, and raincoats, while others had to be hard and durable, such as combs, fountain pens, and insulating objects. The degree of hardness is determined by the amount of sulfur present in the rubber. This varies from 2% for soft, flexible articles to 35% for extremely hard articles. But sulfur is not the only substance used in the manufacture of rubber. Various pigments are used to color it, accelerating agents were found to speed up the reaction with sulfur, while other ingredients were discovered to give it body and other qualities such as toughness and resistance to abrasion, non-conductivity, and resistance to heat. These were the things which the chemist discovered in his many experiments with both the raw and the finished product.

The first pneumatic tires were invented by Robert William Thompson, of London, in 1846. They were known as "patent aerial wheels." But the pneumatic tire did not come into use until after 1888. John Boyd Dunlop, of Belfast, one day tied a rubber tube around the wheel of his little son's velocipede. Seven years later a $25,000,000 corporation was busy manufacturing Dunlop tires.

With the advent of the automobile and the consequent demand for rubber, to be used in the manufacture of tires, the rubber "boom" of 1909–1910 came on. Men roamed the jungles of Brazil and Africa, madly in search of the valuable "Black Gold" and rubber rose to the stupendous price of $3.00 a pound. This was the seed which started the development of the rubber plantation systems.

Plantation rubber may be said to have started in about 1876 when Sir Joseph Hooker, then director of Kew Gardens near London, obtained a quantity of seeds from Brazil. Of all the seeds delivered to Kew Gardens only 2800 germinated. Of these seedlings a few were sent to the botanical gardens at Singapore and the rest to Ceylon. In 1881 these trees seeded and distributions were made to Java, the Malays, and India. Thus the plantation systems originated with a few seeds.

Again we owe to the chemist the credit for the development of the plantation systems. Studies were made of the trees and of the best ways to propagate them. The latex was analyzed in so far as it was possible. A new improved method for separating the rubber from the latex was discovered. Briefly, this consisted of adding acetic acid to the latex, after which the pure rubber coagulated, floated to the top, and could be removed. The rubber was then pressed into thin sheets and sent to be dried or smoked, after which it was packed in large bales. From the raw latex, coming from the tree, to the finished product, the rubber is almost entirely under the supervision of the chemist.

Let us follow the process through from the latex to the completed rubber article.

The latex is obtained from the rubber tree by making incisions in the bark and collecting the juice which runs out.

The rubber may be obtained from the latex in either of two ways. The first, mentioned above, is by coagulation, that is, by treating the latex with acetic acid. The coagulated rubber is separated, washed, and dried. The second method is by spraying the latex into a heated chamber. The latex flows upon an elevated disk which is revolving rapidly, thus hurling it into a stream of heated air. The water is evaporated by the heat and the rubber falls to the bottom of the chamber as fine particles which form a sort of sponge. This sponge is compressed into blocks for shipment.

When plantation rubber arrives at the factory it is usually ready for compounding or mixing. Wild rubber must first be washed and dried.

The rubber to be washed is placed in tanks of warm water to soften it. It is then cut up into small pieces by powerful knives and put through the cracker. The cracker is a massive machine consisting of two corrugated steel rollers, rotating toward each other at different speeds. The rubber is fed into this and comes out torn into ragged pieces. A stream of water is continually flowing on the rubber during this process. After this the rubber

is fed through a washer until it comes out a thin sheet resembling crêpe. A washer is a machine similar to a cracker except that it has finer corrugations. After washing the rubber is ready to be dried. This is accomplished by hanging the sheets of rubber in a dark room through which is passed a current of warm air.

The rubber is now ready for mixing. This consists of passing it through a mill made up of two heavy, polished rollers which rotate toward each other at slightly differing speeds. As the rubber goes through the mill the filler is added and the process continues until a homogeneous mass is formed. The sulfur and accelerator are usually added after the fillers have been thoroughly mixed with the rubber.

The next operation is that of calendering, by which the sheets of rubber of any desired thickness are procured. The temperature required for the particular compound to be made is regulated by means of steam and water connections to the calender.

The next step in the process is the most important one, that of vulcanization or curing. This consists essentially of combining the rubber with sulfur and may be done in any one of several different ways. If the sulfur has been mixed with the rubber beforehand, any one of the methods employed in the curing simply involves heating in some form or other. There are a few methods of vulcanization which do not require heating and these are worthy of explanation.

The cold cure consists in dipping the rubber article in a solution of one to three per cent sulfur chloride in either carbon bisulfide, carbon tetrachloride, naphtha, or benzine. This method is used only for thin articles. The bath cure consists in dipping the rubber articles in molten sulfur. In the vapor cure rubber articles are subjected to a treatment with sulfur chloride vapor.

The gas cure is performed by exposing the rubber to hydrogen sulfide and sulfur dioxide successively at room temperature. An active form of sulfur is liberated by the action of one gas on the other. This vulcanizes the rubber.

Rubber articles are made in various ways. Some are molded and vulcanized while in the molds. Some, rubber hose for example, are first formed from the sheet rubber, wrapped on huge drums or put into a cage and then vulcanized. Still others, as pneumatic tires, are built up from a combination of sheet rubber and fiber impregnated with rubber; an extra heavy sheet of rubber is put on the top; this is for the formation of the treads. The whole thing is then put into a mold and subjected to heat which vulcanizes it.

The chemist has not only discovered ways of making natural rubber useful, but he has also discovered how to reclaim old rubber and how to make rubber synthetically.

The process of reclaiming rubber is not as yet quite perfect, but every year the chemists are discovering new and better ways of extracting the rubber from old, worn-out articles. The rubber to be reclaimed is first sorted according to classification. It is then finely divided and passed through screens and magnetic separators. Rubber containing fiber is treated with dilute sulfuric acid which destroys the fiber. The rubber is then washed and passed over riffles to remove sand and metal. The mass is then softened by mixing with oils, tars, or other softening agents, after which it is passed into large digesters where it is exposed to live steam at a pressure of 100 to 150 pounds. This treatment removes a great part of the sulfur and plasticizes the rubber. It is impossible to remove all of the sulfur by any of the processes at present known to man and this is one of the fields in which the chemist is now at work. Reclaimed rubber, although not so good as new rubber, is still a very valuable material when properly compounded to meet the service required of it.

The story of synthetic rubber is the story of what the chemist can do in the case of an emergency. Professor Tilden of England in 1892 discovered that isoprene is the basic constituent of rubber. Isoprene can be obtained from turpentine, but for a long time it was not known how to convert isoprene into rubber. Dr. Mathews, another English chemist, experimenting with isoprene in 1910, one day set a bottle of it to dry over sodium. Two months later he discovered that the bottle, instead of containing a colorless liquid was filled with real rubber. However, the discovery was not epoch-making, as one might think, for isoprene could only be obtained from turpentine which in turn was obtained from pine trees. Why cut down the pine trees instead of the rubber trees? After a number of experiments it was found that isoprene could be obtained from starch. A process of fermentation was discovered by which a large amount of fusel oil could be obtained from starch. By the use of chlorine, isoprene can be prepared from fusel oil. The chain was complete and synthetic rubber was a fact.

Synthetic rubber is still more expensive to produce than natural rubber and it is up to the chemist to discover more economical means for its production. Much use was made of synthetic rubber during the World War by Germany; but this was only because she could obtain no natural rubber.

No matter how much synthetic rubber is made or how many rubber trees are planted the surplus will never go to waste. There are many things for which rubber might be used. It might be used to pave the streets (and I believe this has been tried in Scotland with great success) and side walks and give us added ease and comfort in walking or riding. Even the subway and elevated might be made almost noiseless and certainly much more comfortable by the use of rubber.

There are still many things for the chemist to discover about rubber and there is a great amount of work to be done. There is the process of

reclaiming rubber to be improved and perfected. Most of the reactions in the manufacture of rubber are not yet fully understood and the discovery of these would lead to new and better ways of production resulting in an improved product. Then there is the synthesis of rubber to be further investigated at which, even now, our own great chemist and inventor, Thomas A. Edison, is working.

Chemistry today is battling, battling with the seen and the unseen, with the known and the unknown. The world looks on with eager eyes and keen criticism, nurturing greater realization of the impossible becoming possible. Chemistry is making everything possible and who knows that probability is not the next step forward? What end can there be? Where is the finality of life when men's minds are creating such wonders for the universe?

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Platinum. The resistance of platinum to solution in acids, its non-tarnishing qualities, its high melting point, and the fact that its electrical resistance is higher than that of most other metals, fit it for many special uses in which its comparative softness and lack of brilliancy are not objectionable. Platinum forms many useful alloys. One of the most recent of these contains 3 to 5 per cent of the rare metal rhodium. This alloy is softer than the platinum-iridium alloys, and is superior to these for chemical laboratory apparatus, since it tears much less readily and suffers lower losses by volatilization when it is heated to high temperatures over long periods of time.

Platinum in a spongy or finely divided form is used as a catalyzer in the chemical industries, enabling many chemical transformations to be carried out at comparatively low temperatures and with ease, which in the absence of platinum can hardly be accomplished at all. The high price of platinum, at present about $70.00 an ounce, or nearly four times the price of gold, has led to a determined search for substitutes, that have displaced it from many of its former uses. Nevertheless, insufficient attention has been paid to the possibilities of platinum in thin films for purposes to which its special properties, mentioned above, would seem to fit it. It is not readily deposited by electroplating, nevertheless continuous films can readily be obtained upon glass or porcelain. A film only three-millionths of an inch thick is continuous, has a metallic luster, and a square foot of such a film contains only forty cents' worth of metal.—*Industrial Bulletin* of A. D. Little, Inc. (Apr., 1929).

WINNERS OF HIGH-SCHOOL PRIZE ESSAY CONTEST, 1928–29

The American Chemical Society recently announced the national winners in its sixth prize essay contest for high-school students. The prizes are being awarded to the writers of the best essays on each of six subjects relating to chemistry. Each prize consists of a four-year tuition-paid scholarship and $500 each year at any approved college or university in the United States.

Ray Lyman Wilbur, Secretary of the Interior, is the new Chairman of the National Awards Committee which selected the prize-winning essays, succeeding President Hoover who has occupied the chairmanship since the beginning of the contest in 1923.

The successful students are the following:

C. JELLEFF CARR The Relation of Chemistry to Health and Disease	Evening High School, Baltimore City College, Baltimore, Md.
RUTH KNOBLE The Relation of Chemistry to the Enrichment of Life	Flathead County High School, Kalispell, Mont.
GUINEVERE CROUCH The Relation of Chemistry to Agriculture	Boise High School, Boise, Idaho.
AMAZIAH PARKER SMITH The Relation of Chemistry to National Defense	Chapel Hill High School, Chapel Hill, North Carolina.
MORGAN L. WALTERS The Relation of Chemistry to the Home	Rock Springs High School, Rock Springs, Wyo.
JOHN DOUGLAS MARTIN The Relation of Chemistry to an Industry	Soldan High School, St. Louis, Mo.

The prizes for the contest and the funds for its conduct are the gift of Mr. and Mrs. Francis P. Garvan of New York City, made as a memorial to their daughter Patricia.

Eight of the national prize winners of the past five contests have been graduated from college; nineteen are now in attendance at college, and the remaining three will enter college next fall.

The contest, designed to stimulate a better appreciation of chemistry, is annually conducted in each State, where the prizes are $20 in gold and the participation of the winning essays in the national contest. The contest will be repeated in 1929–30, as will the other two contests for college freshmen and normal school and teachers' college students, also conducted by the American Chemical Society with funds provided by Mr. and Mrs. Garvan.

If we don't discipline ourselves the world will do it for us.

THE HISTORY AND PRESENT STATUS OF THE JABER PROBLEM*

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Since the beginning of the 14th century, alchemical literature has contained writings ascribed to Geber. The most extensive and most important of these is a manuscript in the Staatsbibliothek at Munich. It dates, perhaps, from the 13th century and bears the title "*Liber (Geberi) de Transmutatione Metallorum.*" The later manuscript copies and the printed specimens since 1541 have the title "*Summa Perfectionis Magisterii*" (The Whole of the Preparation of the Elixir). The other writings are the book "*De Investigatione Perfectionis,*" the book "*De Inventione Veritatis,*" the "*Liber Fornacum*" (The Book of Furnaces), and the "*Testamentum Geberi.*" The relationship of these is established, or at least created, by the constant references to the "*Summa;*" only the "*Testamentum,*" by far the shortest of the treatises, lacks such references, and other details also indicate that it is not a product of the author of the other works.

Further search for evidences of the common origin of the four treatises reveals that they all are divided into short, well-ordered chapters collected into larger sections; the style is clear and free from all magic and mysticism; and a wealth of good observations is everywhere interspersed among the discussions of the fantastic theory of metallic transmutation. Consequently, these four treatises and their author, Geber, deservedly enjoyed great prestige. Although in the oldest known manuscript he is called simply Geber, he later received the title, *Philosophus Perspicatissimus*, or *Philosophus Rex Persarum* or *Maximus Philosophus Ac Rex Indiae*, or *Rex Arabum*. Some follow the lead of *Leo Africanus*[1] and declare that he was a native of Greece who accepted Islam and taught Greco-Arabic philosophy in Seville.

Even as early as the 18th century, doubts arose concerning the generally accepted Arabic authorship of these works. George Ernest Stahl (1660–1734), the renowned chemist and physician and creator of the phlogistic hypothesis in his book, "*De Sulphure*" (1718), declared the works of Geber for the most part fictitious and questionable throughout. Beckmann,[2] the author of excellent contributions to the history of science, in 1800 as-

* Translated and annotated by Ralph E. Oesper, University of Cincinnati.

[1] LEO, JOHANNES (1494–1552), usually called Leo Africanus, was probably born in Granada of noble Moorish stock. His best known work is "*Africae Descriptio*" long ranked as the best authority on Mohammedan Africa. He also wrote lives of Arabic physicians and philosophers.

[2] BECKMANN, JOHANN (1739–1811), German scientific writer noted chiefly for his "*Beiträge zur Geschichte der Erfindungen*" which has appeared in English translation. He is regarded as the founder of scientific technology, a term he was the first to use in 1772.

serted that the writings were 12th century forgeries; Reiske[3] called Geber the mythical author of alleged alchemical works; Wüstenfeld,[4] in his "History of Arabic Physicians and Scientists" (1840) distinguished definitely between the works of Jaber and the translations of the books of Geber, published under the former's name; the physician Gottlieb Latz in 1869 declared that the Latin treatises of Geber never were based on an Arabic original, but that the occidental writings of a fictitious author were held to be Arabic creations. Finally, in 1871, Steinschneider,[5] on the basis of his examination of the Jaber writings, showed that the knowledge imputed to Geber was not to be found in the works of the true Jaber.

This was the state of affairs when Hermann Kopp,[6] with the aid of the Orientalist, Gustav Weil (1808–1889), critically examined and compiled the available information on the Geber or Jaber problem. His findings were published in 1875 in his "*Beiträge zur Geschichte der Chemie.*" He showed that even the "*Fihrist*" of Ibn an-Nadim[7] contained no certain data concerning the identity and life of the Arabic Geber nor of the authenticity of the numerous works ascribed to him. Even the titles of the books listed in the "*Fihrist*" are not those of the alleged Geber treatises. Likewise, Ibn Challikan[8] and Haddschi Khalifa[9] do not mention these Latin

[3] REISKE, JOHANN J. (1716–1774), German scholar and physician. He was an ardent student of Arabic literature and probably surpassed all his predecessors in the range and quality of his knowledge in this field.

[4] WÜSTENFELD, FERDINAND (1808–1899), "*Geschichte der arabischeu Ärtzte und Naturforscher,*" Göttingen, **1840.**

[5] STEINSCHNEIDER, MORITZ (1816–1907), Jewish bibliographer who also wrote much on Arabic literature.

[6] KOPP, HERMANN (1817–1892), German chemist, distinguished not only for his physico-chemical researches, but also for his "*Geschichte der Chemie,*" in 4 volumes, 1843–1847, and 3 supplements, 1869–1875.

[7] Abulfaraj Mohammed ibn Ishaq ibn Abi Ya'kub an-Nadim. He is the author of the "*Fihrist-al-Ulum*" (lists of the books of all nations that were to be found in Arabic) which is often referred to as "*Kitab al-Fihrist*" (book of the catalog). His work was added to and was finally closed in 987. Later writers give the date of his death as 996. The "*Fihrist*" includes notices of the authors and other particulars. Especial interest attaches to a list of 51 of the most noted "philosophers" beginning with Hermes and Chymes down to the time of al-Razi, together with the titles of their most important works so far as this is possible, for some wrote so many "books" that individual mention was impossible. Imperfect manuscripts of the "*Fihrist*" are in Paris, Leiden, and Vienna. This work gives a complete picture of the most active intellectual period of the Moslem world.

[8] Abu'Abbas Ahmad ibn Khallikan (1211–1282), Arabian biographer. His great work is "*Kitab Wafayat al-A'yan*" (The Obituaries of Eminent Men). It contains, in alphabetical order, accounts of the lives of celebrated persons of Moslem history and literature. An English translation exists (1842–1871).

[9] Haddschi Khalifa (d. 1658) was one of the most famous men of letters whom Turkey has produced. He wrote learned works on history, biography, chronology, geography, etc.

works nor do they name anything that may have been the Arabic originals. According to Weil, there are no characteristics indicating that these Latin texts may be translations from the Arabic and no Arab, either of the same or later period, had knowledge of the facts recorded in the Latin writings. Furthermore, all the Latin Geber texts exhibit good scholastic form and composition; they are not cited before 1300; there are no manuscript copies of an earlier date, but rather many later ones. These considerations compel the conclusion that no direct connection between the Arabic writings of Jaber and the Latin ones of Geber has either been demonstrated or made credible.

The publication of a translation of that portion of the "*Fihrist*" dealing with the history of chemistry and also translations of a number of Arabic treatises of Jaber Ibn Hayyan by O. Houdas in Berthelot's[10] "*La Chimie au Moyen Âge*" only substantiated and strengthened Kopp's conclusions. Berthelot decided that the Arabic texts he made accessible (like all the Arabic writings) were far removed from the Latin writings of the pseudo-Geber and no page or paragraph could be found in the latter which might be regarded as translations of the published Arabic texts.

The next quarter of a century produced no new findings. Renewed impetus in the study of the source material of historical chemistry came from the publication in 1919 of von Lippmann's monumental work on "The Origin and Spread of Alchemy."[11] This is a condensation of our whole knowledge of Greek, Arabic, and Latin alchemy, and it presents a wealth of facts. Shortly thereafter, in 1922, Darmstaedter's German translation of the Geber treatises[12] appeared, and this is especially valuable for its commentary. The question as to the source of Geber's knowledge and the identity of those who discovered and developed the new facts appearing in the Latin treatises was not brought nearer a definite answer by Darmstaedter. This is not to his discredit for the problem will never be solved until the Latin and Arabic manuscripts of the Middle Ages have been made accessible and much more minutely studied.

The identity of the Arabic Jaber will now be considered in detail. The writer has been tracing the sources of the chemistry of Razi (Rhazes)[13]

[10] BERTHELOT, MARCELLIN P. (1827–1907), French chemist distinguished for his work in organic synthesis, thermo-chemistry, chemical mechanics, and agricultural chemistry. In the later years of his life he turned his attention to the history of chemistry. Among his historical works are, "*Les Origines de l'alchemie*" (1885); "*Introduction a l'étude de la Chimie des anciens et du moyen âge*" (1889); "*La Chimie au Moyen Âge*" (1886).

[11] VON LIPPMANN, EDMUND O. (1857–), The preceding paragraphs follow rather closely p. 485 ff. of his "*Entstehung und Ausbreitung der Alchemie,*" Berlin, **1919.**

[12] "*Die Alchemie des Geber übersetzt und erklärt,*" von Ernest Darmstaedter (1877–1928), Berlin, **1922.**

[13] Abu Bakr Muhammad ibn Zakariya al-Razi (850–923 or 932, or 860–940) noted Arabic physician. al-Baihaqi (1105–1169) in his "Biographies" writes: "al-Razi

whose "*Kitab sirr al-asrar*" (Book of the Secret of Secrets)[14] he found in Göttingen in 1920. Of necessity, these studies led to Jaber, *i. e.*, to the statements of the "*Fihrist*" and also to the texts published by Berthelot. It seemed likely that critical examination of the biographical and bibliographical data of the "*Fihrist*" might eventuate in more definite views of Jaber's life and accomplishments. The contradictory nature of the reports even as early as the end of the 10th century is best evidenced by the following unabridged excerpt from Ibn an-Nadim. He wrote:

Jaber's full name was Abu'Abdallah Jaber ibn Hayyan ibn 'Abdallah al-Kufi;[15] he was also known as as-Sufi.[16] The writers are not in agreement in their reports concerning him. The Shiites[17] believe him to have been one of their great men and one of their gates; they also say he was an associate of Ja'far and lived in Kufa. One group of philosophers, on the other hand, claim him for their own and state that he wrote on logic and philosophy. The adepts of the art of preparing gold and silver claim that he was the grand master of their profession in his time; but they add that he had to remain in hiding and moved constantly from city to city, never remaining long in one place because he feared persecution at the hands of the authorities. Certain other authors state that he was a retainer of the Barmecides[18] to whom he was wholly devoted, especially to Ja'far ibn Yahja.[19] Those who report this also believe that Jaber in his references to his "Master Ja'far" alluded to the Barmecide, while the Shiites maintain that he meant Ja'far as-Sadiq.[20]

A trustworthy man has told me that Jaber lived in a street near the Syrian Gate of Kufa and preferred this city because of its excellent climate and because he prepared the Elixir there. The same authority also told me that a golden mortar weighing

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was originally a manual laborer, who later pursued alchemy with great zeal and injured his eyes through the vapors of the materials employed in the preparation of the Elixir. He went to a physician who said to him, 'I will not cure you until you have paid me 500 dinars.' Al-Razi paid him and said, 'This is the true Alchemy and the real art of making gold, rather than the way I have been following.' Thereupon he abandoned the art of the Elixir and devoted himself to medicine."

[14] Ruska, J., *Zeitschrift für angewandte Chemie*, **35,** 719 (1922).

[15] Abu = father of; ibn = son of.

[16] Sufism was a system of Mohammedan mysticism originating in the 8th century and developed in Persia into an elaborate symbolism. Its purpose was to gain an insight into the Divine Being through ecstasy and contemplation.

[17] Shiism is one of the great divisions of Mohammedism. Its adherents claimed that all the rights in the succession belonged to Mohammed alone, and consequently, they rejected the first three caliphs and regarded Ali, his son-in-law, as the rightful successor of the prophet. Persia was the center of this sect. A'Gate is a figurative expression for an intermediary between mankind and Divinity, often not direct, but rather a person between humanity and the hidden Imam, who is the representative of Divinity.

[18] A wealthy noble Persian family which furnished viziers to Harun al-Raschid and the earlier Caliphs of Bagdad.

[19] One of the ministers of Harun al-Raschid, beheaded in 798 (?) for political reasons.

[20] Abu Abdallah Ja'far ibn Muhammed ibn Ali as-Sadiq (699–765) sixth Imam of the Alides, the descendants of the Caliph Ali (d. 661). Noted for his knowledge of astrology, alchemy, and philosophy.

200 pounds was found when a hall on the site of Jaber's house was torn down, and nothing else was found there except this mortar and a room for dissolving and fixing materials. A number of scholars and bibliographers have assured me that this Jaber never lived, and others say that if he lived he wrote no book except the "*Kitab ar-rahma*" (Book of Clemency);[21] the other works bearing his name were all ascribed to him by other writers. As for me, I affirm that a man of merit who sets to work to write a book of 2000 pages, devoting his whole spirit and all the resources of his mind to the task; to say nothing of the toil of the actual writing, and then issues the work under another's name, is simply a fool; for what profit can come to him for all his work? No one does such things, and so Jaber really did live, his personality is assured, he is the author of many important works. He wrote treatises on the tendencies of the Shiites which I shall mention elsewhere and works on the various sciences which I have enumerated above. It is also said that he was born in Khorasan and had two pupils, al-Kharaqi, for whom the street in Medina was named, and Ibn 'Ijad al-Akhmimi.

This confused and contradictory mass of biographical reports appears very perplexing at first. If, however, the two indexes of the works of Jaber, given in the "*Fihrist*," are also taken into consideration some light is thrown on this obscurity, and at least it is worth while to try to distinguish more sharply between the credible and the incredible. It is claimed the two catalogs originate with Jaber himself. The first contains an exact enumeration of 267 treatises on alchemy grouped under sub-heads. The second is made up of summaries and numbers, by hundreds and thousands, the writings in other fields of knowledge. Each of these lists will be considered in detail.

No lengthy discussion of the first catalog is necessary. The dedication of some of the works to the Barmecides proves Jaber's close connection with this powerful family of ministers. The name "Ali ibn Yaqtin"[22] leads us into the circle of the Shiites. The linking of Jaber with the Imam Ja'far seems credible if the date of Jaber's birth is taken as considerably prior to 750; in any case, he cannot have died as early as 776, as is stated in several places by Haddschi Khalifa. The acceptance of Ja'far as-Sadiq, the Later, as a chief proponent of occult knowledge in Shiistic circles adequately explains his connection with Jaber, but it lays open to suspicion every text in which the two names are obtrusively joined. Although there is independent evidence for regarding Jaber as an adherent of Sufism, the lack of more exact information about his theological treatises is very regrettable. A study of the chemical titles establishes a distinct disparity with Greek alchemy and indicates the relationship of Jaber's ideas to the alchemy of al-Razi. Such investigations justify Jaber's reputation as Founder of Arabic Alchemy and make it obligatory to determine the authenticity of

[21] A treatise on transmutation.

[22] Yaqtin, the father of Ali, was a freedman of Mahdi, the father of Harun al-Raschid. He was intrusted with many important works, particularly with the renewal and supervision of roads.

the works published under his name and whose contents have deservedly brought censorious judgments against him.[23]

It is of prime importance to trace the sources of Jaber's chemical knowledge. A thousand years of tradition conferred on the Imam Ja'far the honor of being Jaber's instructor in the art of transmuting metals. Although this assumption seems incredible in view of the Imam's historical position, nevertheless, a fundamental, authoritative study of this tradition was essential in order that this report not only be refuted, but its origin determined. Likewise, the tradition that the Ommiad[24] prince Chalid ibn Jazid[25] was an alchemist and a forerunner of Jaber was deemed worthy of investigation. The writer believes that he has disproved these traditions[26] and cleared the way for discovering the true sources of the new chemistry taught by Jaber. This could not have come from Alexandria, nor from Medina nor Kufi. Jaber must have acquired his knowledge in Persia itself and most probably in Khorasan, his native province, the home of the astrologers and astronomers, who, after the victory of the Abbassides[27] flocked to the new capital Bagdad. This thesis as to the origin of Arabic science has been fully developed elsewhere by the writer and it will be sufficient here to cite the publications.[28]

Since 1922 the English investigator Holmyard has been engaged in parallel studies and has published material on the Jaber problem.[29] His most striking conclusion is in contradiction to the generally accepted view, for he believes that Jaber ibn Hayyan was the original author of the Latin Geber works. His reason is that the content of these works differs only slightly from those of certain Arabic ones whose authenticity has never been questioned. The latter are not the texts brought to light by Berthe-

[23] Ruska, "*Über das Schriftenweizeichnis des Gabir ibn Hajjan und die Unechtheit einiger ihm zugeschriebenen Abhandlungen.*" Sudhoff Festschrift, *Archiv. für Geschichte d. Medizin*, **15,** 53 (1923).

[24] The Ommiad dynasty of Caliphs reigned in the East from 661–750. They were succeeded by the Abbassides.

[25] Chalid ibn Yazid ibn Mu'awijah (635–704) is alleged to have been the first of the Arabic alchemists. After fruitless attempts to become Caliph he retired to Alexandria and spent his time in the study of medicine, astrology, and alchemy. According to the "*Fihrist,*" the earliest Arabic translations of the Greek works were made at his behest.

[26] Ruska, J., "*Arabische Alchemisten I und II,*" *Heidelberger Akten der von Portheimstiftung*, C. Winter, Heidelberg, **1924.**

[27] The Abbassides were the dynasty of Caliphs claiming descent from Abbas, the uncle of Mohammed. They overthrew the Ommiads in 750.

[28] Ruska, J., "*Uber die Quellen von Gabir's chemischen Wissen,*" *Archivio di Storia della Scienza*, **7,** 267 (1926). See also Chapter VIII of Ruska's "*Tabula Smaragdina, Ein Beitrag zur Geschichte der hermetischen Literatur,*" Heidelberg, **1926.**

[29] *Nature*, **110,** 573 (1922); **111,** 191 (1923); **112,** 525 (1923); *Sci. Progress*, **17,** 252 (1923); **18,** 66 (1924); **19,** 415 (1925); *Chem. & Ind.*, **42,** 387, 958 (1923); *Proceedings of Royal Soc. Med.*, **16,** 46 (1923).

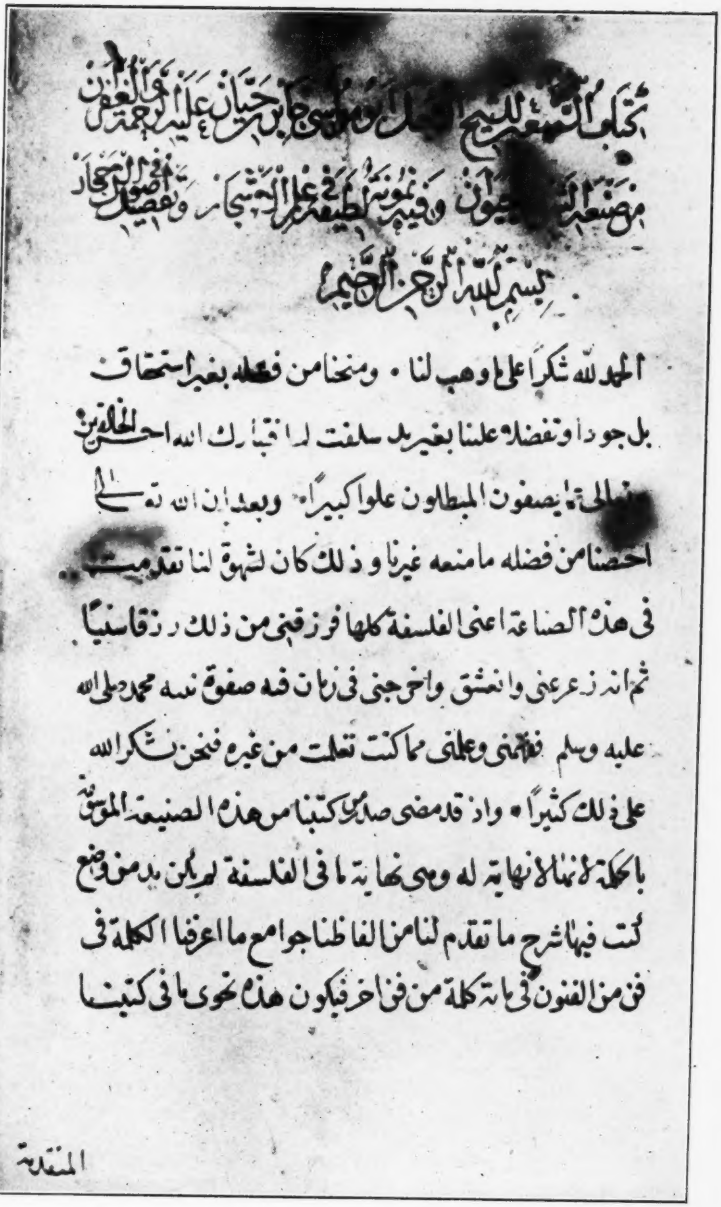
lot, but are eleven treatises which have come into Holmyard's possession as part of a very rare lithographed collection from India. They belonged to the collection of 112 books disclosed by the great chemical list discussed above, and worthy of especial attention among them are those treatises from the first part of the list which were dedicated to the Barmecides. Holmyard has also made further searches in the library catalogs, seeking Latin and Arabic works of Jaber, and has compiled a list of some fifty titles of his writings which only await scientific study. The eleven treatises will appear shortly.

The writer also obviously felt the necessity of going beyond the Berthelot texts and of making a study of the wealth of manuscripts whose existence Holmyard indicated. The libraries of Cairo were searched for scientific texts, particularly those of Jaber. Several valuable finds were made in the National Library, and in June, 1925, he learned that the library of the recently deceased Nureddin Bey Mustafa contained a manuscript collection of alchemical works that included some Jaber items. A study of the titles disclosed the presence of not less than 46 of the "Book of the Seventy,"[30] the second largest list of the alchemical writings. Another collection of alchemical manuscripts was found in the possession of Ahmed Pasha Taimur. A preliminary report on the study of the photostatic copies of these invaluable manuscripts has been published and a German translation of the texts with commentary is now being prepared.

A second and more unexpected find in the library of Ahmed Pasha Taimur was Jaber's "*Kitab as-Summum*" (The Book of Poisons). This work of some 250 quarto pages treats of poisons and toxicology and is mentioned once in the "Book of the Seventy" and once again in the "*Kitab al-mawazin*" (The Book of Balances).[31] The genuineness of this work is vouched for not only by these two references, but by its whole content with its continual references to other writings of Jaber, and also by the style of presentation. It takes us back at least 70–80 years before Sahl at-Tabari (838–923) wrote his medical and scientific work "*Firdaus al-hikma*" (The Garden of Wisdom); in content, though with complete independence of form and choice of subject matter, it takes us closer to the Greek sources

[30] A book of this title is listed in the "*Fihrist*" as the work of Jaber. A crude Latin translation (?) is preserved in the *Bibliothéque Nationale* at Paris. It deals chiefly with the preparation of the Elixir and its application. See Ruska, J., "*Die Siebzig Bücher des Gabir ibn Hajjan*," *Studien zur Geschichte der Chemie, Festgabe für Edmund O. von Lippmann*, p. 381, **1927.**

[31] This alchemical treatise is based on the thesis that although all material contains the four elements, fire, water, earth, and air, the "great work" requires that they be present in the proper proportion. The secret of the adept consists in his knowledge of the various materials to be taken in order to consummate the proper balance and hence, the transmutation.


كتاب السبعين للشيخ الجليل ابو موسى جابر بن حيان عليه الرحمة والغفران
من صنعة [illegible] وفيه نونية لطيفة في علم الحجار وتفصيل في اصول الاحجار

بسم الله الرحمن الرحيم

الحمد لله شكرا على ما وهب لنا . ومنحنا من فضله بغير استحقاق
بل جودا وتفضلا علينا بغير ما سلفت لنا تبارك الله احسن الخالقين
تعالى ما يصفون المبطلون علوا كبيرا . وبعد ان الله تعالى
احصنا من فضله ما منعه غيرنا وذلك كان لشهوة لنا تقدمت
في هذه الصناعة اعني الفلسفة كلها فوزقني من ذلك رزقا سنيا
ثم انه زعزعني وانعشق واخرجني في زمان فيه صفوة نسمه محمد صلى الله
عليه وسلم فعلمني وعلمني مما كنت تعلمت من غيره فنحن نشكر الله
على ذلك كثيرا . واذ قد مضى صدر كتبنا من هذه الصنعة الموسومة
بالكلة لانها لا نهاية له وهي نهاية ما في الفلسفة لم يكن بد من وضع
كتب فيها شرح ما تقدم لنا من الفاظنا جوامع ما اعرفها الكلة في
فن من الفنون في ماية كلة من فن اخر فيكون هذا نحو ما في كتبنا

المقدمة

First Page of the "Kitâb al-sab(ina" (Book of the Seventy) by Jâbir ibn Hayyân (Constantinople Mss.)

than does any known medical treatise of the Arabs; it discloses an undreamed of wealth of scientific and other writings of Jaber.

The second list will now be considered. As stated above this enumerated in the form of summaries hundreds and thousands of Jaber's writings. In the following excerpt Jaber is reported to have said,

> I have written 300 books on philosophy; "one thousand" 300 books on the tricky arts in the style of the "Book of Taqatir"[32] and "one thousand" 300 essays on all kinds of crafts and instruments of warfare. I have also written a great book and many smaller and large treatises on medicine, in all about 500 books, such as the "Book of Touching and Anatomy." Moreover, I have written books on logic, according to the system of Aristotle. Furthermore, I have written the elegant "Book of Astronomical Tables" of about 300 pages, a "Commentary on Euclid" and a "Commentary on the Almagest;"[33] the "Book of the Mirror" and the "Book of the Torrent" which the theologians tried to refute. In addition, I have written books on asceticism and devotional topics. I have also written many nice books on incantations and exorcism, and concerning the specific properties of things. Besides these, I have also written 500 books to refute the philosophers, a chemical book bearing the title, "The Book of Royalty,"[34] as well as a book "The Gardens."

It is impossible to accept this list as reliable even though the "one thousands" before the 300 are deleted as due to a mistake in transcription,[35] thus reducing the number of writings from 4000 to 2000. Nor is it scarcely possible if we assume that the majority of these "books," like those of the chemical "Book of the Seventy" are only short treatises of a few pages each. However, the verdict that the list was an unabashed forgery, that Jaber could not have written a commentary on Euclid and Ptolemy, that Pythagoras and Socrates have no place in a list of chemical writings, all these and many similar objections which the writer raised on the basis of the sources available in 1924, can no longer be upheld.

The study of the "Book of the Seventy" and the "Book of Poisons" has shown that nothing is impossible with Jaber. At every step, these texts

[32] Taqatir = perhaps the Book of Distillations, but it may be the name of an unknown chemist, or the miswritten name of a known chemist.

[33] A celebrated work of Ptolemy which contains most of what is known of the astronomical observations and theories of the ancients. An Arabic translation was made about 827.

[34] This, "the fifth of the series of five hundred," claims to give clearly and without allegory rapid and simple procedures for transmuting metals. These are designed especially for kings and noblemen who have neither the patience nor knowledge requisite for the longer processes. Instead of 70 years as required by many methods, the new recipes are claimed to take only 14 or 9 days, in fact, only an instant is sufficient to accomplish the transmutation provided the "Ferment of Ferments," whose preparation is here described, is available. Of course no more definite information concerning the "Elixir of Elixirs" is revealed than appears in other treatises of this nature. Emphasis is placed on keeping the secret well, for if gold becomes as common as glass the whole world will be plunged into terrible corruption and decay.

[35] Allaftu = I have written or composed, may have been transcribed as alif = 1000.

reveal the logical and philosophical training of the author. The list, once assailed by the writer, is given a secure position on many points by the references in these works to numerous writings of Jaber included in the list. One of the most surprising examples is the occurrence in the "Book of Poisons" of a long quotation from a treatise on military strategy. It must be conceded that Jaber was a pioneer chemist, but also an excellent pharmacist and physician. Proofs are at hand of his wide scientific knowledge. Why, then, should there be doubt as to his activities in the fields of mathematics and astronomy? The Arabic tradition begins with the astronomers Naubackt and Maschallah about 750; the history of mathematics begins with Muhammed ibn Musa al-Khwarazmi,[36] the author of the algebra and of a treatise on Indian numerals. Could not the Indian numerals have been used long before this by the Persian astronomers? In one place in the "Book of the Seventy," Jaber speaks of the zero as though it were nothing unusual, and this was at least 60 years before al-Khwarazmi wrote his pamphlet for a wider circle. For such reasons all fields of the history of Arabic science will have to be fundamentally relearned, in order that the facts revealed in Jaber's writings may be included in any future history of the Sassanian[37] kingdom and of the development of Oriental Hellenism.

The question as to Jaber's origin and the particulars of his life have been cleared up in a remarkable manner by Holmyard. He has also given a clear answer, at least on the most important points, as regards Jaber's relation to Ja'far as-Sadiq and to Shiism. Although the writer is not inclined to accept Holmyard's thesis that Jaber and Geber were identical, he does agree with the findings as to Jaber's origin. Holmyard's results may be summarized briefly.

According to the "*Fihrist*," Jaber was a native of Kufa, while other writers say he was called at-Tusi, *i. e.*, he was born in Tus; the headings of the treatises published by Berthelot frequently add al-Azdi (of the tribe of Azd). Holmyard has shown that the south Arabic Banu Azd (sons of Azd) lived in a special quarter of Kufa, so that a Kufic might still be referred to as belonging to the tribe of Azd. However, it is much more illuminating that even the name at-Tusi can be brought into harmony with the other names if it is granted that Jaber's father was the druggist Hayyan, whose propagandistic activity in Khorasan is recorded by ad-Dinawari in his *Kitab*

[36] A famous Arabic mathematician who flourished in the reign of Harun al-Raschid's son, Ma'mum (813–833). He explained the use of the decimal system in Arabic. The first mention of the word algebra occurs in the title of his "*Kitab al-gabr walmuqabalah.*" He is responsible for the introduction of Indian numerals and methods of counting into Islam.

[37] The Sassanian dynasty of kings reigned in Persia from 226 until 641 when they were overthrown by the Arabs.

al-Achbar at-Tiwal.[38] Hayyan was one of the circle of Shiites who in the year of the Hegira 101 (720 A.D.) swore unconditional fealty to the Imam Muhammed ibn Ali, the father of Abu-l'Abbas.[39] He was sent to Khorasan with Abu'Iqrima, in order that in the guise of itinerant merchants they might incite the populace against the Ommiad governor Sa'id. After two years they both returned to report their success, but on their second visit to Khorasan they were detected by the men of the new governor, Asad ibn 'Abdallah, taken into custody and beheaded. There is no reason for not assuming that Hayyan married in Tus and that Jaber was born there of a Persian mother, and of a south Arabic father of the tribe of Azd. Then at the death of the Imam Ja'far as-Sadiq, 765 (?), Jaber would have been 44 or 45 years old, and as one of the esteemed leaders of Shiism could have been closely associated with the Imam who was some 20 years his senior. In bona fide works of Jaber he refers to Ja'far as Master; the opinions only differ as to whether Jaber thus acknowledged his discipleship in theological and dogmatic matters or whether he also ascribes his chemical and scientific knowledge to Ja'far's teachings. Holmyard believes that even though the latter may not have actually worked with sulfur and mercury he at least had a theoretical acquaintance with the occult sciences. The writer does not agree with this, but, on the other hand, thinks that the solution of many of these knotty problems may be found if it is kept in mind that even at that time there was a general fundamental belief that all science, including also that of the Greeks, Indians, and Persians, was immanent wisdom revealed by God to the prophets, especially to Mohammed and Ali. It may be surmised that the same theory was applied to the Imam Ja'far shortly after his death.

The history of science will not be the only field to gain from these studies; the history of Islam and its relations with the thought of the new Orient with which it is inextricably intertwined, the infinitely important question of the embodiment of Hellenism in Islamism, are all sure to profit greatly from investigations of Jaber's writings.

[38] Ad-Dinawari (died 896) wrote a universal history, "The Long Narratives." Much of Holmyard's information is derived from a manuscript of ad-Dinawari found by Sir Henry Stapleton. See Holmyard, "An Essay on Jabir ibn Hajjan," *Studien zur Geschichte der Chemie, Festgabe für* Edmund O. von Lippmann, pp. 28–37.

[39] For details concerning these struggles for the caliphate see article "Caliphate" in Encyclopedia Britannica.

He who is silent is forgotten; he who abstains is taken at his word; he who does not advance falls back; he who stops is overwhelmed, distanced, crushed; he who ceases to grow greater becomes smaller; he who leaves off, gives up; the stationary condition is the beginning of the end.—AMIEL

THE PURIFICATION OF PEPSIN

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Pepsin is the proteolytic enzyme of the gastric juice. It possesses the power of peptonizing typical proteins, *i. e.*, of hydrolyzing them to proteoses and peptones.

Gastric digestion was first considered as a purely physical action, and was explained by the friction of food particles under the influence of pressure exerted by the walls of the stomach. Reaumur[1] (1683–1757) was the first to demonstrate the influence of the stomachal juice in the phenomenon of digestion. His experiments consisted in causing falcons to swallow tubes pierced with holes and filled with food. He found that after a certain time these substances, although protected from friction, were completely digested. Spallanzani[2] a few years later demonstrated that gastric juice retained its power for dissolving flesh even after its removal from the stomach. To procure gastric juice Spallanzani caused a tame eagle to swallow a sponge fastened to the end of a cord. By drawing the sponge out and squeezing it he obtained the juice sought.

However, the very clear data of Reaumur and Spallanzani were not accepted by the scientific world of the period. Experiments, the results of which contradicted each other, left the question still in doubt, so that physiologists for a long time disagreed on the subject of the mechanism of digestion. Some attributed it to effect of vital and nervous force, others assumed the intervention of the gastric juice, although it was then considered only salivary juice which had undergone acidification. The study of digestion, abandoned for some time, was again actively taken up between 1820 and 1840. Tiedmann, Gmelin, Leuret, and Lassaigne[3] showed anew that digestion is due to the gastric juice. They further established that gastric juice is not to be confounded with saliva, but is, on the contrary, secreted by the glands of the stomach. In 1836 Schwann[4] showed that the digestion was due to an enzyme presented in the gastric juice and to this active principle he ascribed the name pepsin, which means "digestion."

Pepsin is secreted by the glands of the stomach in an inactive form, pepsinogen. This pepsinogen is converted into pepsin by the hydrochloric acid of the gastric juice. Like all other enzymes pepsin is very sensitive to high temperatures and variations in the hydrogen-ion concentration of the solution. The optimum hydrogen-ion concentration for its action is

[1] Reaumur, *Me. de l'Acad. des Science*, **1752**, p. 461.

[2] Spallanzani, "*Vers. ub. d. Verdauungsgescheft*," Deutsch von Michaelis, Leipzig, **1785.**

[3] Leuret and Lassaigne, "*Recherches physiologiques et chimiques pour servir a l'histoire de la digestion*," Paris, Mme. Huzard, **1825.**

[4] Schwann, Muller's *Archiv.*, **1836**, p. 90.

that of about 0.2 per cent hydrochloric acid but it varies to some extent with the protein used. It is very rapidly destroyed by alkaline solutions and it is fairly rapidly inactivated even at a pH of 5 (Northrup).[5]

Many attempts have been made to isolate this enzyme in a pure form and to determine its chemical nature and its ultimate physiological properties. In spite of these efforts the problem remains unsolved. However a discussion of those publications to which we owe our present knowledge of the chemical nature of the enzyme may be of interest.

Pekelharing,[6] by dialyzing, at low temperature, against distilled water, gastric juice from a dog with a gastric fistula, till the concentration of the hydrochloric acid in the juice was decreased to about 0.02 per cent, precipitated the pepsin thereby as a fine suspension. The suspension was separated by centrifuging and after washing with water dried in a desiccator. From the clear fluid left after centrifuging he precipitated, by half saturation with ammonium sulfate, more pepsin which was then freed from this salt by dialysis. Hydrochloric acid was then added to the extent of 0.2 per cent and the solution dialyzed as before against distilled water until an additional quantity of pepsin precipitated out. The average composition of the pepsin so prepared was, C = 51.99, H = 7.07, N = 14.44, S = 1.63, Cl = 0.49, and P = 0.01 per cent. Pekelharing regarded the phosphorus as due to traces of impurities. Ringer,[7] by using oxalic acid instead of hydrochloric acid, obtained a preparation by Pekelharing's method which was free from chlorides and which had a digestive action equal to that prepared with hydrochloric acid.

Hammarsten,[8] by the use of methods which gave him pepsin preparations as active as those of Pekelharing, but of which he made no elementary analysis, generalized from his observations that pepsin is always an enzyme-protein complex. Dezani[9] obtained a very active preparation which contained only 12.02 per cent nitrogen; 16.30 per cent of the total nitrogen was present as basic nitrogen, that is, as arginine, lysine, histidine, and ammonia. The preparation gave the characteristic protein color reactions. Davis and Merker[10] investigated the change in composition of pepsin preparations during purification. They showed that commercial pepsin 1:3000 U. S. P. contained a considerable quantity of secondary protein derivatives as shown by their high amino nitrogen content, while their purest preparation, which had an activity of 1:40,000 U. S. P., had an amino nitrogen content of the same magnitude as native proteins. Their purest

[5] Northrup, J. H., *J. Gen. Physiol.*, **2**, 465 (1920).
[6] Pekelharing, C. A., *Z. physiol. Chem.*, **22**, 233 (1896); **35**, 8 (1902).
[7] Ringer, W. E., *Z. physiol. Chem.*, **95**, 195 (1915).
[8] Hammarsten, O., *Z. physiol. Chem.*, **121**, 240 (1922).
[9] Dezani, S., *Atti. accad. sci., Torino*, **48**, 194 (1910).
[10] Davis, L., and Merker, H. M., *J. Am. Chem. Soc.*, **41**, 221 (1919).

preparation contained 13.77 per cent nitrogen and gave the ordinary protein color tests as well as a very marked Molisch reaction for carbohydrates.

The author[11] in 1927 published the results of a fairly extensive investigation on the purification of pepsin and the chemical constitution of the preparations thus obtained. The most active preparation was obtained by precipitating the enzyme from water solution with safranine after which the precipitate was dissolved in slightly acidified water containing about 20 per cent ethyl alcohol. The dye was then removed by extraction with iso-amyl alcohol, traces of iso-amyl alcohol removed with ether, and the pepsin precipitated by the addition of two volumes of a solution containing equal volumes of ethyl alcohol and ether. The optimum pH for precipitation was approximately 2.5 and corresponds to the determined isoelectric point. After standing for a short time the precipitated enzyme was centrifuged off and dried in a desiccator. The most active material obtained had a digestive power of 1:64,000 U. S. P. Chemical analysis calculated on an ash-free basis showed the following composition, C = 45.24, H = 6.19, N = 11.50, S = 1.79 per cent. Ash was 1.19 per cent. The preparation gave positive Millon's, xanthoproteic, biuret, Hopkins-Cole, and Molisch's reactions for carbohydrates. The Ninhydrin reaction for amino nitrogen was negative although the test was positive after slight hydrolysis with acids.

Fenger[12] and co-workers prepared pepsin of very high proteolytic activity by precipitating it from solution by dialysis at low temperatures against solutions of pH 2.4–2.5. Such preparations showed a maximum digestive action of 1:65,000 U. S. P. Pepsin precipitated from solutions of higher pH, namely 3.0 and 3.8, respectively, though still possessing marked digestive action, was considerably weaker than that precipitated at pH 2.5. Chemical analysis of the various preparations showed some marked differences, *e. g.*, the percentage of phosphorus increased with proteolytic activity while that of sulfur decreased, and chlorine was completely absent in the one precipitated at the isoelectric point, namely pH 2.5. The most active preparation had the following chemical composition C = 53.15, H = 7.20, N = 14.43, P = 0.13, Cl = 0 per cent. All their preparations gave positive Millon's, xanthoproteic, and biuret reactions.

Pepsin is readily adsorbed from solution by various substances such as aluminum hydroxide, charcoal, fibrin, Lloyd's reagent, and albumin. Aluminum hydroxide was used by the author with fair success in the separation of pepsin from some of the accompanying impurities present in artificial gastric juice, and commercial pepsin. McMeekins[13] used egg albumin for the same purpose with considerable success. His most active prepara-

[11] Forbes, J. C., *J. Biol. Chem.*, **71,** 559 (1927).

[12] Fenger, F., and Andrews, R. H., *J. Biol. Chem.*, **73,** 371 (1927).

[13] McMeekins, T. LeRoy, *Science Series*, Univ. of Chicago, **4,** 391 (1928).

tion had a digestive action of 1:52,000 U. S. P. Maximum adsorption was obtained at pH 3 and the adsorbed enzyme was removed from the albumin by using $NaHCO_3$ or Na_2HPO_4 solutions of suitable pH. Solutions of Na_2HPO_4 of a pH of 6.1 to 6.2 were found the most effective. The purified material contained 12.8–13.8 per cent nitrogen. It gave positive biuret, xanthoproteic, and diazo reactions as well as tests for phosphorus and a reducing substance.

In view of the differences in the chemical analysis of the various pepsin preparations obtained by different authors, using different methods, it seems fairly evident that the isolation of pure pepsin is left for the future. Pepsin is very readily adsorbed by proteins and it is generally believed that its digestion of proteins is through mass action promoted by its adsorption on the substrate. It is therefore very probable that in ordinary solutions of it most of the pepsin is present in such association with the protein and these consequently will tend to be precipitated with it. The variations in the chemical constitution of the preparations obtained by different authors may then consequently be explained on the assumption that an enzyme-protein adsorption compound was obtained in each case and that the protein part of the complex was not always the same. The methods employed by Fenger and by Pekelharing are practically the same, the pepsin being precipitated in both cases by dialyzing the solution against distilled water of suitable hydrogen-ion concentration until the pepsin precipitated out. The chemical analyses of their preparations also agree very closely and correspond to that of an albumin. The preparations of Dezani, McMeekins, and the author were obtained by different methods and have a much lower nitrogen content than those of Pekelharing and of Fenger. Their chemical analysis, especially that of the author's, corresponds fairly closely to that of some glycoproteins. The glycoprotein character of the author's preparation is further emphasized by the strong Molisch test and the liberation of a reducing substance on hydrolysis with acids.

One of the main difficulties encountered in the purification of pepsin is the ease with which it is inactivated, especially in the purer state. Fenger has shown that at pH 3.8 and above the enzyme disintegrates so that the particles will pass through parchment or animal membranes with a gradual decrease in the proteolytic activity of the solution. The decrease in proteolytic activity seems to go hand in hand with a decrease in the protein characteristics. It is indeed possible that pepsin cannot exist as such except in a protein-enzyme complex and that the enzyme is inactivated if freed from such combination. The enzyme is very sensitive to the action of alkali, heat, or strong acids, it being immediately inactivated in alkaline solutions or by boiling.

The ultimate explanation of the phenomenon of gastric digestion must be

preceded by a thorough understanding of the structure of the enzyme and of its combination with the substrate on which it acts. It is hoped that the day is not far distant when this important physiological phenomenon will be explained, as a thorough understanding of the action of even one enzyme might throw a great deal of light on the various physiological actions which make up what we understand as life.

Chemical Possibilities of Fluorine. Fluorine, the gaseous chemical element heretofore isolated in only small quantities, has been produced electrolytically in thousand cubic feet quantities by Profs. Wilder D. Bancroft and Newton C. Jones of Cornell.

As a result a new method of analyzing complex organic compounds will be developed. Determining just how some chemicals are put together has been difficult because dissociation with electric current, a fruitful method for some compounds, cannot be used on solutions that do not react to electricity. Fluorine, however, reacts with almost any organic substance, whether electrolytically conducting or not, and it displaces that portion of the substance that would have appeared at the anode pole if the substance had been electrolyzed.

These findings and possibilities were reported to the recent American Electrochemical Society meeting at Toronto. Profs. Bancroft and Jones also discovered that fluorine when it reacts with benzene does so explosively although this was unexpected in the light of properties of the two gases hitherto known.

Large quantities of fluorine occur in different parts of the earth's crust but it is practically almost tightly locked in combination with other elements. One of the common minerals containing it is fluorspar. In school chemical laboratories students know one of fluorine's compounds, hydrofluoric acid, because of its property of etching glass.—*Science Service*

Tuberculosis Germ May Occur in Two Forms. Tuberculosis germs grown artificially may play strange tricks on scientists by occurring in two forms, one being comparatively harmless and the other being very virulent, Dr. S. A. Petroff of Trudeau, N. Y., reported recently to the National Tuberculosis Association at the opening session of its 25th annual meeting at Atlantic City.

Scientists who grow disease germs on a synthetic diet instead of human tissues and cells, favored by the germs, have known that some of the germs so grown appear in two forms, but this is the first knowledge that the germ of tuberculosis plays a dual rôle. Heretofore the tubercle bacillus, as it is called in scientific circles, has been considered one of the most stable of germs.

The two forms differ on other particulars besides virulency, but this difference is found in the bacillus of human, bovine, and avian tuberculosis, and in the bacillus used by Prof. Calmette of the Pasteur Institute, Paris, in his famous Calmette-Guerin vaccine against tuberculosis. This unsuspected difference may account for the unsatisfactory results reported by American scientists with the B. C. G. vaccine. A vaccine made from what was supposed to be the harmless tubercle bacilli would have an unfortunate effect on the subject vaccinated if the bacilli suddenly changed to the virulent form. This change may move in either direction, that is, from virulent to harmless or the reverse, and may occur either within or without the human body, Dr. Petroff reported.—*Science Service*

REMSEN AT THE TURN OF THE CENTURY

FRIEND E. CLARK, WEST VIRGINIA UNIVERSITY, MORGANTOWN, WEST VIRGINIA

In October, 1898, I knocked at Professor Remsen's office door and was invited to enter and to sit in a chair quite close to his desk. There was considerable anxiety upon my part as to what might happen. Would the candidate for admission to graduate work be subjected to a series of questions concerning chemistry; might he be asked to translate a page from German or French journals; or would the professor inquire about the Latin that had preceded the study of modern languages? All of these much thought of possible inquiries excited me very much. However, nothing of that nature happened. On the contrary, Professor Remsen began to inquire most sympathetically concerning my arrival in that city, where I had stopped for the first night, and what plans had been laid for the future. He directed me to the University Y. M. C. A., at the same time pointing in the general direction of Levering Hall. Before leaving his office, I walked to the window, pointed diagonally across the street and asked Professor Remsen if that were the Y. M. C. A. building. I shall never forget the amused expression of his face as he replied, "No, Mr. Clark, that is a building almost as important. It is a branch of the city fire department." After this incident, I found it easier to ask other questions which were most courteously and helpfully answered.

At the time of entering the university, my work in organic preparations had not progressed as far as that of the average student. Therefore, at the end of the first year, I asked Professor Remsen if he would approve my going to a certain Virginia college for a portion of the summer in order to get a little more done on organic chemistry. Remsen quickly recalled the name of a former student of his who had charge of the laboratory and gave his consent, at the same time expressing his wish that a number of students might go there for the same purpose. This suggestion was followed, and in the fall he was keenly interested in the results of our summer's work.

I recall his unique way of making statements and references to the literature. One illustration will suffice here. Quinoline was up for discussion and preparation. He began by pointing to the much spotted ceiling of the laboratory and remarked that he wished the reflux condenser might be pointed in a certain direction, in order to insure uniform decoration of the ceiling and walls. He then came close to the desk and occupied my laboratory stool, making sure, first, that the desk was clean before placing his elbow on it. (All of Professor Remsen's students will recall how immaculate he was at all times and, furthermore, will remember how careful we were to have at least one clean towel close at hand to be exhibited when he was making his rounds.) Some signs of uneasiness doubt-

H. A. ROWLAND
Professor of Physics

W. H. WELCH
Professor of Pathology

B. L. GILDERSLEEVE
Professor of Greek

D. C. GILMAN
First President

IRA REMSEN
Professor of Chemistry

Of this group, all except Professor Welch were members of the original faculty of The Johns Hopkins University.

less developed on the part of the students when these daily interviews got under way. This time the conference was ended happily by Professor Remsen, who, after checking on the quinoline set-up, remarked, "That is the compound that discovered Skraup." This way of expressing the historical fact made a deep impression, so that I have repeated the story to my students of organic chemistry each year.

It was soon noticeable to the students of these years that Professor Remsen was meditating on matters of special importance, for sometimes he would pass through the laboratory at the accustomed hour without stopping to speak to any of us. He was preoccupied at times. Before long we understood that he was balancing his duties to the chemistry department and his duties to the University if he should accept the Presidency of the University which had been offered to him. He began his duties as President fully expecting to keep his work in chemistry going as before and this he did for many years. In time, however, his efforts were drawn more and more to the larger field. One reference to his letters will support the belief that he reluctantly spent much time away from chemistry. In 1914 he wrote,

> I have taken up some of my old chemical problems again and shall devote my time largely to laboratory work from this time forth and I ask for no better occupation. It appeals to me much more than presidential work. Inanimate things are easier to deal with than animate, especially if the animate are in human form.

And in the same year, he wrote,

> This is simply to let you know that I have got back from my wanderings over the face of the earth. I had a very pleasant time. I traveled over twenty thousand miles without a hitch and reached home a few days ago in the best of health. Things look bright to me here.

Professor Remsen's letters were always pointing to the future when he would renew his researches more actively. In March, 1915, he wrote,

> I cannot deny that I am enjoying life. My bodily health is excellent and the relief from heavy burdens of the presidency are most welcome. I am getting some insight into those two chlorides.

> which have so long bothered me, and I think we shall soon be able to solve that knotty problem. At all events we have recently obtained some very interesting results and each day brings something that stimulates thought and that makes life enjoyable.

Two years later, March, 1917, Professor Remsen wrote,

> My work this year has given me real pleasure and keeps me in the best of health. I have an assistant at work leisurely and we are getting something out. This occupation

is most agreeable to me and it does no harm to anyone so far as I know. I lectured up to February on historical subjects and the staff asked me to continue. So, apparently, although I have recently passed my seventy-first birthday anniversary, I am not yet entirely useless. And I am not yet willing to lead a life of idleness. I tried that for a few months and that was more than enough.

Professor Remsen's personal interest in his students was most gratifying. He remembered details that one would not expect. I remember his conversations with former students during the exercises at the fiftieth anni-

Courtesy of The Sunpapers

WHEN JOHNS HOPKINS WAS DOWNTOWN

Left foreground, students' Y. M. C. A.; behind it, McCoy Hall, which later was burned. Right foreground, biological (Levering Hall) and chemical (Dalton Hall) laboratories; right background, Hopkins Hall.

versary celebration of the founding of the University. He recalled something about each man to whom he spoke. For instance, to me he said, "Clark, I shall call you Friend tonight." Expressing my approval, I ventured to inquire, "Why not make it Ebenezer?" to which he replied, "No, not that, but let us make it Friend." In this way he passed through the admiring group of former students to the speakers' table.

These remarks are recorded here with affectionate regard for the memory of Ira Remsen.

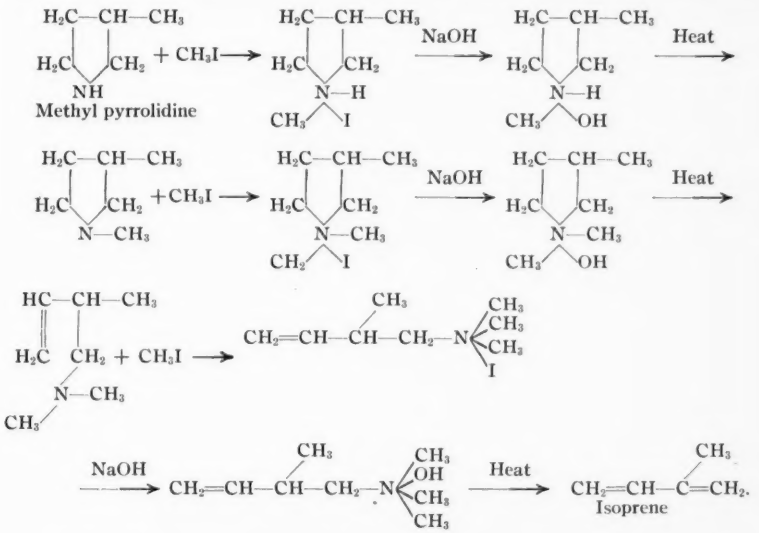
THE OUTLOOK FOR SYNTHETIC RUBBER

OSCAR LEO BRAUER, SAN JOSE STATE TEACHERS' COLLEGE, SAN JOSE, CALIFORNIA

The possibility of synthetic rubber suddenly appearing on the market to supplant the natural product, greatly stimulates the popular imagination. In this day of chemical miracles, who can say that the synthesis of rubber is not near at hand? English and Dutch plantations are producing ninety per cent of the rubber used today. The United States uses considerably over half of this supply, which puts us completely at the mercy of foreign capital and influences. We should, however, be thankful that the English and Dutch capitalists had the foresight to put out these rubber plantations and provide a supply equal to the world's needs. The wild rubber trees could not have met this demand at all. Nevertheless, American rubber users have felt that we should not be entirely dependent upon foreign monopolies. Sudden rises in price due to the restriction in the production by the British have greatly accentuated this feeling. Furthermore, there is always the possibility of war suddenly cutting off the supply entirely, which would leave us in an embarrassing predicament.

The possibilities of American owned rubber plantations have been considered from many angles. In 1925 Mr. H. S. Firestone announced the Firestone Plantations Company, which planned a million acre plantation in Liberia. In six or eight years this plantation ought to produce 250,000 tons of rubber, over half the world's present supply. According to the newspapers, Mr. Henry Ford has purchased a large tract of land in the Amazon Valley for a similar rubber plantation. Mr. Edison is attacking the problem from a slightly different angle. His plan is to develop a plant rich in rubber that will be hardy enough to grow in Florida. Another attempt to develop American grown rubber is being made in the Salinas Valley in California. Here the guayule bush from Mexico is being grown. Guayule rubber, although not equal to the Para variety, is of fairly good quality.

Previous to the European War, it was known that isoprene, whose formula was established as $CH_2{=}C(CH_3){-}CH{=}CH_2$ is among the decomposition products of rubber, and that it could be polymerized into a rubber-like substance that gave all of the chemical tests for rubber. Isoprene could be obtained in small quantities from the destructive distillation of turpentine, but the yields were so small that it was little more than a laboratory curiosity. Isoprene had been synthesized by one circuitous set of processes, but which offered no promise of economical production. This method consisted in the exhaustive methylation of methyl pyrrolidine.



Two other substances closely related to isoprene were also known to polymerize into rubber-like substances. They were butadiene, $CH_2{=}CH{-}CH{=}CH_2$ and dimethyl butadiene, $CH_2{=}C(CH_3){-}C(CH_3){=}CH_2$. It will at once appear that isoprene is methyl butadiene. These substances, like isoprene, gave little promise as possible sources of rubber.

What the Germans accomplished during the war is an eye-opener to the possibilities of synthetic caoutchouc.[1] They were extremely limited as to possible raw materials, coal being the only feasible substance. However, at the close of the war, Germany was producing ten tons of synthetic rubber daily, which was a noteworthy achievement.

Naturally, this war-born material could not compete with the superior plantation rubber. However, the experience of the Germans shows us that synthetic rubber is a commercial possibility, when processes are sufficiently cheapened and the quality sufficiently improved to enable the artificial rubber to really compete with the natural substance.

Although the German process is not necessarily the best, it is worth considering, since coal will no doubt always be one of our cheapest raw products. It is in outline as follows:

$$1.\ \underset{\text{coal}}{C} + \underset{\text{lime}}{CaO} \xrightarrow{\text{Electric furnace}} \underset{\text{calcium carbide}}{CaC_2}$$

[1] Oenslager, G., "Change in the Rubber Industry during Past Fifty Years," *Ind. Eng. Chem.*, **18**, 902–5 (Sept., 1926). Burgdorf, C. C., "Artificial Rubber during the War with Germany," *Ibid.*, **18**, 1172–3 (Nov., 1926).

2. $CaC_2 + H_2O \xrightarrow{\text{Simply mix}} C_2H_2$ (acetylene)

3. $C_2H_2 + H_2O \xrightarrow{\text{Heat together with Hg salt}} CH_3{-}CHO$ (acetaldehyde)

4. $CH_3{-}CHO + O \xrightarrow{\text{Any good oxidizing agent}} CH_3{-}CO_2H$ (acetic acid)

5. $2\,CH_3{-}CO_2H + Ca(OH)_2 \xrightarrow{\text{Neutralization}} (CH_3CO_2)_2\,Ca + 2H_2O$

6. $(CH_3CO_2)_2Ca \xrightarrow{\text{Heat dry salt}} (CH_3)_2\,CO + CaCO_3$
calcium acetate → acetone

7. $2\,CH_3{-}CO{-}CH_3 \xrightarrow[+\text{caustic soda}]{\text{Reduce with Al}} \left(\begin{matrix} CH_3 & CH_3 \\ | & | \\ OC & -CO \\ | & | \\ CH_3 & CH_3 \end{matrix}\right)_3 Al_2$
Al salt of pinacol

8. Distil Al pinacol under pressure $CH_2{=}C(CH_3){-}C(CH_3){=}CH_2$,
methyl isoprene or dimethyl butadiene

9. Dimethyl butadiene is polymerized into rubber by heating to 60°C. for 4–6 months.

The Bayer Company under Merling patents worked out a method of obtaining isoprene from coal.[2] From coal to acetone the process was the same as that just described. The rest is as follows:

Acetone + sodium amide → sodium acetone, $CH_2{=}C(ONa){-}CH_3$
sodium-β-allyl alcoholate

Sodium acetone + acetylene → $CH_3{-}C(CH_3)\,(OH){-}C{\equiv}CH$
methyl butinol

Methyl butinol + Zn dust → $CH_3C(CH_3)\,(OH){-}CH{=}CH_2$
methyl butenol

Methyl butenol + $MgSO_4$ → $CH_2{=}C(CH_3){-}CH{=}CH_2$
isoprene

The fact that there are so many steps in these processes suggests expense and dwindling yields. It explains why they could not survive peacetime conditions. However, the question of yields usually resolves itself into a problem of the best conditions of reaction, or possibly a suitable catalyst. No chemist would dare assert that the weakest links in the chain might not be made the strongest by a little organized research. The appearance of synthetic methanol on the world markets produced consternation in the wood distillation industries. Before the war, synthetic methanol had little economic promise, but here it is, full-grown and able to meet any competition. A recent announcement that a German concern had contracted to make cheap synthetic gasoline out of coal is causing considerable

[2] Weil, R., "Synthetic Rubber," *Ind. Eng. Chem.*, **18**, 1174–7 (Nov., 1926).

speculation. May not synthetic rubber be next? It is not probable that German rubber research stopped with the peace treaty. In fact a recent announcement shows that the Germans are busily at work on synthetic rubber.[3] The German Dye Trust at Frankfurt announces that it will be able to produce the raw materials for synthesis of rubber and gutta percha.

Coal is by no means our only natural resource that might be used as a starting point in rubber synthesis. Our large acreage of corn places starch as a possibility. Perkin and Matthews[4] have already developed a method of getting isoprene from starch.

Fermentation with pure culture
Starch $\longrightarrow$ iso amyl alcohol

$$(CH_3)_2{-}CH{-}CH_2{-}CH_2OH + HCl \longrightarrow (CH_3)_2\,CH{-}CH_2{-}CH_2Cl$$

isoamyl alcohol — isoamyl chloride

$$(CH_3)_2{-}CH{-}CH_2{-}CH_2Cl + Cl_2 \longrightarrow (CH_3)_2C(Cl){-}CH_2{-}CH_2Cl$$

isoamyl dichloride

Pass vapor of dichloride over soda-lime $\longrightarrow$

$$CH_2{=}C{-}CH{=}CH_2$$
$$\quad\;\; |$$
$$\quad CH_3$$

isoprene

Yields as yet do not make this a highly successful process. However, every chemist suspects that it could be made entirely successful by enough study. The conditions of reaction and suitable catalysts no doubt hold the keys of success.

The obtaining of an artificial rubber to compete with the natural substance to any degree resolves itself into cheaper isoprene and better methods of polymerization. Butadiene and dimethyl butadiene might serve successfully, but the isoprene rubber seems to be the best. Harries[5] succeeded in polymerizing cyclopentadiene and related substances into rubber-like materials but at present this does not promise a successful process. If the solution of the rubber problem is in isoprene, butadiene, or dimethyl butadiene, it may rest in a cheap source of alcohol, acetone, acetic acid, or some hydrocarbon. This suggests the possibility of working up wood waste, which at present yields at least three of these substances. Recent work in low- and high-temperature carbonization[6] suggests possible modifications of present methods of treating wood waste to increase the yields of either acetone, alcohol, or acetic acid.

We have probably overlooked our "best bet" for synthetic rubber in the unsaturated hydrocarbons found in the oil industry. We may be burning

[3] German Synthetic Rubber, *Ind. Eng. Chem.*, **20,** 182 (Feb., 1928).

[4] Weber, L. E., "Is Commercial Synthetic Rubber Probable?" *Ibid.*, **18,** 404–6 (Apr., 1926).

[5] Bruson and Staudinger, "Cyclopentadiene Rubber," *Ibid.*, **18,** 381–3 (Apr., 1926).

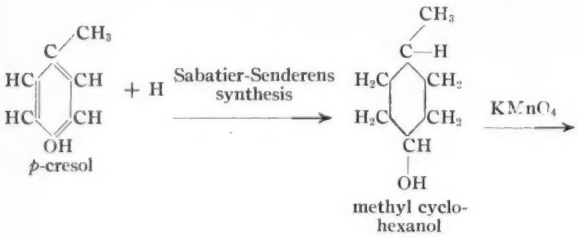
[6] Parr, S. W., "Future Trends in Low-Temperature Carbonization," *Ibid.*, **18,** 1015–6 (Oct., 1926).

substances much more valuable for synthetic work than for fuel. This is almost a virgin field. Unsaturated hydrocarbons occur in many natural oils. Especially are they found in the "cracked" gasolines. This suggests the modification of the cracking process so as to favor some particularly desirable hydrocarbon for rubber synthesis. Suppose the cracking could be modified to produce:

2 methyl butane, $(CH_3)_2—CH—CH_2—CH_3$

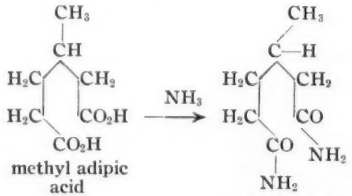
$$(CH_3)_2—CH—CH_2—CH_3 + Br_2 \xrightarrow{\text{sunlight}} (CH_3)_2—CH—CH_2—CH_2Br$$

The rest of the process would be the same as Perkin and Matthew's process, given earlier in the article. Another process that suggests wood waste, such as sawdust and the vast amount of limbs and sap wood incident to the lumber industry as a starting point is the Hoffmann and Coutelle process.[4] This process gets isoprene from *p*-cresol.



p-cresol

methyl cyclohexanol

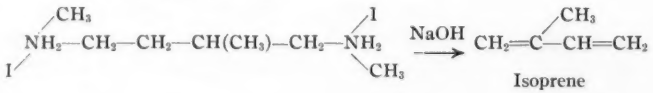


methyl adipic acid

methyl adipic acid amide

$$Br_2 + NaOH \longrightarrow NH_2—CH_2—CH(CH_3)—CH_2—NH_2 \xrightarrow{2CH_3I}$$

tetra-methylene diamine



Isoprene

This process for synthetic isoprene suggests a method for synthetic rubber. Isopropanol is a by-product of the oil industry. It could readily be reduced to acetone and converted to isoprene or dimethyl butadiene according to the German process chosen.

Synthetic rubber up until now, besides not being able to compete with the natural product in price, is inferior in quality. The inferiority is along the line of plasticity, elasticity, and abrasive resistance. However, Mr. L. E. Weber says it is comparable to the poorest natural rubber. This is saying a great deal.

Artificial rubber need not compete with natural rubber in all of its many uses. If it can successfully replace the natural substance in the fields of hard rubber and electrical insulation it may be considered a success. Probably a better knowledge of the physical make-up of natural rubber will enable the investigators to improve the synthetic rubber. Its deficiency may be physical rather than chemical.

Professor Fessenden[7] found that a copper sphere filled with water, when compressed between two flat surfaces, could be shortened 10% with only a 1% straining of the copper. A large object made of such spheres soldered together would compress or lengthen as a whole very greatly and with only a minute lengthening of its constituent parts. In this way it represents rubber. The rest is best expressed in Professor Fessenden's own words.

> It would also resemble rubber in other ways. The metals follow Poisson's Law, *i. e.*, a rod of copper increases in volume when stretched and diminishes in volume when its ends are compressed to quite a large amount. But rubber does not, nor would a rod made of water filled copper balls.
>
> Rubber heats when stretched, instead of cooling, and so would the rod of water-filled copper balls, because the water in the balls is really compressed when the rod is stretched. Also, if a stretched rod of rubber is heated it contracts instead of expanding as a rod of copper would. And so would the rod of water filled copper balls, because the water would, in expanding, try to make the balls return to their original round shape.

The theory of Professor Fessenden quoted above, and developed about 1892,[8] has since been directly verified in the case of rubber. Hauser and Freundlich[9] showed that the physical unit of Hevea rubber, the latex particle, consists of small pear-shaped drops up to 3 microns in size, with an outer layer of protein, overlying a shell of stiff hydrocarbon and an inner mass of softer hydrocarbon. Attempts have been made to measure the dimensions of the rubber molecule with x-rays,[10] and thereby determine the number of isoprene units in it. The results are not in full agreement, but average about 6 isoprene units. Hauser removed the outer protein covering and found the resulting rubber to be very poor in quality. Others[11] have failed to verify his results. However, it is safe to say that

[7] "The Inventions of Reginal Fessenden," *Radio News*, p. 383, Sept., **1925.**

[8] *Elec. World*, July 16, **1892.**

[9] *India Rubber J.*, **69,** 663 (1925).

[10] Katz, *Chem.-Ztg.*, **49,** 353 (1925). Clark, G. L., "X-Rays and Colloids," Colloid Symposium Monograph, IV, Chemical Catalog Co., New York City, **1926,** p. 145.

[11] Dinsmore, R. P., "Composition and Structure of Hevea Rubber," *Ind. Eng. Chem.*, **18,** 1140–5 (Nov., 1926).

the unusual elastic properties of the natural rubber are partly due to its physical structure. When the synthetic rubber can be made up in physical units similar to the latex particle, there may not be a very great difference between the quality of the natural and the synthetic rubber.

It would not be a rash prophecy to predict that commercial synthetic rubber is coming and may be just around the corner. The fact that chemists are holding rubber symposiums is a hopeful sign. Teachers of organic chemistry should stimulate an interest among their students in this problem and give them all of the facts to date.

Fight Is on against New Billion Dollar Tree Disease. Encouraged by a Congressional appropriation of $35,000, experts of the Department of Agriculture have outlined a comprehensive campaign to stamp out larch canker, a new tree disease similar to chestnut blight, which threatens timber valued at more than $3,000,000,000.

Dr. Haven Metcalf, in charge of the Office of Forest Pathology and generalissimo of scientific forces battling the disease has announced that practically all of the 3100 trees known to be infected have been destroyed. These trees were located in Massachusetts and Rhode Island and comprise, in addition to larches, specimens of the Douglas fir and yellow pine.

An army of men throughout the United States have been instructed to be on the lookout for the disease and have received photographs and descriptions to facilitate their search. This army includes all officers of the U. S. Forest Service, inspection officers of the Department of Agriculture and State officials. These men will report immediately where stands of the yellow pine and Douglas fir are located, particularly east of the Mississippi.

In addition, an accurate check is being made on importations of the three species infected, since the disease came in on trees from Europe prior to enactment of the plant quarantine law in 1918. The customs records are being combed to find where the trees came from so that the department may trace the trees to where they were planted in the United States.

Five men are now working on laboratory studies of the disease, and later in the season this corps will be increased to twenty. Two scientists, Dr. E. P. Meinecke and Dr. Glenn G. Hahn, have been conducting studies of larch canker in Europe, and conferring with experts abroad. The laboratory studies are extremely complicated, owing to the fact that the fungus is one of a group of more than 100 species, whose characters have not been well separated and which are difficult to differentiate.—*Science Service*

Alcohol Found in Injured Oranges. Small amounts of alcohol have been discovered in oranges that have been stored in an atmosphere which contained a high concentration of carbon dioxide, and a low concentration of oxygen. This result has been obtained by Mrs. Onslow and Dr. J. Barker, working at the Low Temperature Station, Cambridge, England. In one experiment the oranges injured by carbon dioxide contained 0.64 g. of alcohol in 100 cc. of orange juice, while controls kept in the air only contained 0.03 g. per 100 cc. Oranges which had been frozen, then thawed and kept in the laboratory, showed practically no increase in alcohol content. It is hoped that determinations of the alcohol content of oranges may serve to indicate the cause of certain abnormal conditions that are sometimes found commercially.—*Science Service*

THE ORIGIN OF VOLTAIC ELECTRICITY. PART II.* THE CONCEPT OF E. M. F. OR THE ENERGY PRINCIPLE

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Lavoisier, at the end of the eighteenth century, had proved beyond a reasonable doubt the "law of the conservation of mass." Before energy relations could be intelligently discussed, the fact that energy can neither be created nor destroyed had to be not only postulated, but also proved. This was very difficult to accomplish because the ideas concerning energies and forces which were current at the beginning of the nineteenth century were as vague and conflicting as they were almost infinitely numerous. The sensibly different "forces" had to be correlated and shown to be more or less interchangeable, though only qualitatively, to be sure at first, but nevertheless inter-convertible. Then the quantitative study was required to obtain the final acceptance. We are interested here primarily in the inter-convertibility of chemical and electrical energies, and the quantitative proof.

Volta was able to determine the rate of discharge of a gold-leaf electroscope by pairs of various metal sheets in contact with each other. The relation between pairs of metals was an indication of the intensity of contact: the numbers indicate the relative intensity of the pairs in the table.[1]

Pb : Zn = 1	Zn : Pb = 5
Cu : Ag = 1	Zn : Cu = 5
Fe : Cu = 2	Zn : Fe = 9
Zn : Fe = 3	Zn : Ag = 12

Volta considered the following order to give the indication of decreasing intensity, which series is now known as the electromotive series: Zn, Pb, Sn, Fe, Cu, Ag, Au. About this period, numerous investigators were ordering the metals in slightly different sequences, but there is no need to notice their divergences of opinion. It suffices to mention the fact.

Faraday had sensed the possibility of electromotive force in current electricity as one of the results of his experimental work but was unable to formulate it into a law. He was, of course, working at the time before the relationship between the different forms of energy were actually understood or appreciated, much less proved.

In 1841 Joule announced one of the first laws that were to relate electricity and heat; *i. e.*, "The heat evolved in a given time by voltaic action is proportional to the resistance of the pairs multiplied by the square of the

* Part I, entitled "The Origin of Voltaic Electricity: The Contact vs. Chemical Theory before the Concept of E. M. F. Was Developed," appeared in THIS JOURNAL, **5**, 549–55 (May, 1928).

[1] Letter to Vasalli dated October 24, 1795.

current." This law can also be stated: $W = i^2r$, in which W is the heat evolved in unit of time by a current i, passing through a resistance r. On the basis of Ohm's law $i = e/r$, this can be transformed into $W = ei$ or $W = e^2/r$. At this time Ohm's law had been stated, and Wheatstone and Poggendorff had perfected the method of measuring small resistances; Faraday had developed his voltameter (the present word is coulometer), on the method of Gay-Lussac and Thenard. While the *intensity* and *electromotive force* of a current were not yet accepted as identical, their relation was forecasted in thought. The accurate measurement of resistance and current was necessary before the concept of energy could be developed.

The first relation between chemical affinity, or energy if you please, and heat of reaction was discovered by Favre[2] when he determined that 18,682 calories of heat were evolved when one gram equivalent of zinc reacted with dilute sulfuric acid. While his numerical results were not so accurate as desired, he was able to understand them and draw conclusions that were far-reaching in their applications. Based on this fundamental work we now have the heats of reaction, heats of formation, etc., as determined by Joule, Thomsen, and others, the well-known Hess Law, and the numerous relations between these values.

Helmholtz was of the opinion[3] that the different chemical materials possessed different affinities for the two kinds of electricity, thus setting up the electrochemical series of metals on a slightly different basis. He developed some heat relations which enabled him to calculate differences in electromotive force as determined by the contemporary Daniell and Grove Cells.

A few years later Lord Kelvin extended Joule's ideas[4] and obtained more nearly quantitative relations, namely, the equivalence of chemical and electrical energies. He, with Helmholtz, believed that chemical energy could always be completely transformed into electrical energy and could be expressed by the equation $E = q/23{,}040$. This, of course, means a complete inter-convertibility of electrical and heat energy; actually it was applicable only in the case in which the galvanic element is neither cooled nor heated, which is the exception rather than the rule. The difference between calculated and observed data was ascribed to experimental errors. The observations of Thomsen[5] and of Braun[6] finally showed the theory to be in error.

These ideas at that time were slightly modified by Joule himself[7] as follows:

[2] Favre, *Compt. rend.*, **66,** 252–70 (1868); **67,** 1012 (1868).

[3] *Ueber die Erhltung der Kraft,* **1847,** Berlin.

[4] *Phil. Mag.* (4) **2,** 429 (1851).

[5] *Wied. Ann.,* **11,** 246 (1880).

[6] *Ibid.,* **17,** 593 (1882).

[7] *Phil. Mag.* (4) **3,** 481 (1852). Quoted from "*Elektrochemie,*" W. Ostwald, Leipzig, **1896,** p. 784.

1. The resistance of a solid conductor produces an evolution of heat which, for a given period of time, is proportional to the resistance of the system and the square of the current.

2. The resistance toward electrolysis possessed by water is no cause for the heat evolution in a decomposition cell. The total quantity of heat which is evolved at the same time in the whole cell, is smaller on account of the E.M.F. drop in the current due to this resistance toward electrolysis. It is reasonable to assume that the heat evolved by the decrease in the current is explained by the heat absorbed by the decomposition cell.

3. The loss in heat evolution due to lowered E.M.F. is completely compensated by the heat evolved by the resistance to polarization so that the total heat equivalent of the entire circuit may be calculated from the chemical reaction of the cell, just as if no polarization were present.

Numerous investigators studied the heat relations on the basis of these ideas. Bosscha[8] and others were dubious about the advisability of attempting to find a close relation between chemical and electrical energies of a system, because of the polarization, and also the interference of primary and secondary reactions, which, as a rule, take place at an electrode surface.

Thermo-chemical laws were being continually clarified by Despretz,[9] Dulong,[10] and Hess.[11] Favre[12] made an elaborate series of investigations on the relations of heat to other forms of energy. Raoult[13] studied the equivalence of chemical and electrical energies and was able from heat relations to calculate some potentials. He developed the opposition method of measuring potentials. He considered polarization to be due to chemical reactions at the electrodes.

Much work was required to prove the relationships of the various forms of energy, and energy relations are the background of all physical phenomena. To the philosophers of the nineteenth century the concept of *force* was fundamental, and all problems were studied from the standpoint of which kind of *force* caused the phenomenon in question. This *force*, now, has to be considered as one of the factors of energy which are intangible, and in electrical questions, this factor is known as the electromotive force.

Kohlrausch[14] came forward with the announcement that electromotive force is proportional to the *electroscopic potential* at the poles of an open circuit, and then he proceeded to calculate e. m. f. values from data obtained from measurements made with an electroscope. The numbers so obtained were not always free from doubt as to their correctness, since the

[8] *Pogg. Ann.*, **101,** 517 (1857); **103,** 487 (1858).

[9] *Ann. chim. phys.*, **26,** 337 (1824).

[10] *Compt. rend.*, **7,** 871 (1838).

[11] Ostwald's *Klassiker*, No. 9.

[12] *Loc. cit.*

[13] *Compt. rend.*, **57,** 509 (1863); **59,** 521 (1864).

[14] *Pogg. Ann.*, **72,** 353 (1847); **75,** 88 and 220 (1848); **78,** 1 (1849); **82,** 1 (1851); **88,** 464 (1851).

method was not absolute. Changes in the construction of apparatus gave different numbers though there was a proportionality between the values. Different investigators obtained numerically different results, so that the mass of data was confusing. For example, for the couple composed of Pb:Cu the values 92.7, 90.1, 81.9, and 74.0 were obtained at different times using the same pair. The basis of the numerical order was the Daniell element which was arbitrarily given a value 100.

Hankel observed[15] that the measured potential decreased with time, even in so short a period as $^1/_2$ or $^1/_4$ minute. He considered that all metals at the first moment of their contact with water were negative, but immediately became positive. Such base metals as zinc gave scarcely any trace of this negative potential, but were predominantly positive from the start. He determined, after the same fashion as did Kohlrausch, the electrical intensity of contact of different metals and assigned the following relative values:

Al: 225–220	Sn: 149	Fe: 116	Au: 90
Zn: 200	Sb: 131	Steel: 116–108	Pd: 85
Cd: 181	Bi: 130	Pig-iron: 116–108	Ag: 82
Pb: 156	Hg: 119	Cu: 100	Pt: 77

The relative intensity of any pair is obtained by subtracting the respective numbers: For example, for the pair Zn:Cu we have: $200 - 100 = 100$; and for the pair Pb:Ag: $156 - 82 = 74$.

It is true that the methods at their best were crude, but the ideas were correct even though difficult experimental details had to be overcome.

Poggendorff, about this time, determined from a long series of investigations that the metals follow the same order of decreasing activity when they are connected in solution as they do when in dry contact. In dilute sulfuric acid he found these values:

Zn:Sn 40.9	Cd:Fe 19.1	Sn:Cu 41.0	Sn:Sb 35.1
Zn:Cu 83.7	Bi:Hg 36.2	Cu:Ag 21.4	Sb:Hg 36.2
Cd:Bi 56.8	Hg:Pt 23.1	Fe:Cu 41.7	Zn (amalgam):Cd 33.9
Fe:Sb 43.7	Zn (amalgam):Sn 53.1	Cu:Hg 35.6	

The values, of course, were different for different electrolytes.

The revised method of Lord Kelvin[16] was a combination of all previous methods, and the development of a composite piece of apparatus called by him an electroscopic electrometer permitted easier and more accurate measurements.

[15] *Abhandlungen d. kgl. sächs. Ges. d. Wiss. phys.-math. Klasse*, **6**, 1; **7**, 585 (1864–65).

[16] *Atti. del Accad. pont. d'nuovi Lincei*, **11**, 177 (1857).

Just a short time before this, Peltier had observed the phenomenon of thermal potential effects by the hot-cold union of different metallic wires.[17] This, instead of clarifying the problem, rather led investigators astray into the belief that all potential phenomena were of thermal origin, which conception is scarcely tenable. The "Peltier-effect" need not be discussed here. It suffices merely to notice that there is a thermodynamic relation between potential changes and temperature. All of this led back again to the relation between the various forms of energy, which, in the case at hand, had to do with the interconversion of heat and electrical energy. There were cases, as mentioned above, in which there was excellent confirmation of the absolute inter-convertibility of these two energies, but investigations showed startling cases of disagreement. The final blow to these ideas came through the medium of Berthelot's "principle of maximum work."

The classical work done (by Willard Gibbs) on heterogeneous equilibria, and contemporaneously, but independently, by Helmholtz, evolved the well-known Gibbs-Helmholtz equation which definitely set up the true relations.[18] The first and second laws of thermodynamics were the basis of the ideas which were so new. Gibbs and Helmholtz were probably the first to assume, and to be able to prove, that in transforming one kind of energy into another the process is often far from quantitatively reversible. The energy which can be converted without limitation into external work was considered as "free" energy. The well-known equation for this is $Q - A = -T(dA/dT)$, in which Q is the total energy change (heat), A is the free energy change, T is the absolute temperature, and dA/dT is the change in free energy with a change in temperature. From this we see that when the rate of change of the free energy of a system is zero, *i. e.*, $dA/dT = 0$, there is complete and quantitative equivalence between the heat evolved and the free energy change.

This equation may be changed to electrical units by substituting nE for A, so that we get $nE = Q + nT\,(dE/dT)$; or $E = Q/n + T\,(dE/dT)$. In this E is the potential change and n is the number of Faradays of electricity passed.

In the Daniell cell the temperature coefficient of potential is zero, *i. e.*, $dE/dT = 0$, and the voltage becomes numerically equal to the heat, which is one case where the laws of Lord Kelvin and Berthelot hold rigidly; in most cases, however, they are not valid. The rules were unfortunately based on the exception, so they are not universally applicable.[19]

[17] *Ann. chim. phys.*, **56**, 371 (1834).

[18] See also the work of Braun, reference 6.

[19] For a verification of this fact, and a numerical statement of others, see: Jahn, *Ann. physik.* (3) **28**, 21 (1886); **50**, 189 (1893); Cohen, Chattaway, and Tombrock, *Z. physik. Chem.*, **60**, 706 (1907); St. Bugarsky, *Z. anorg. Chem.*, **14**, 145 (1897).

This equation now gives us the final statement concerning the interconversion of electrical, chemical, and heat energies.

The work of Gibbs and Helmholtz, however, gave explanation to the total electric potential of cells, whether ordinary cells, as the Daniell cell, or concentration cells, or true gas cells. They gave no consideration to whether or not the potential arose in a single point of contact, or whether the cell potential was a composite of several smaller potentials arising at different points of contact. It is now understood that there is a potential difference set up at the interface between a metal and a liquid, at the interface between two liquids, and at the point of contact between two different metals. A cell potential, so to speak, is a composite of several potential differences.

The Gibbs-Helmholtz equation says nothing about the potential at the interface between a metal and a liquid, *i. e.*, the potential of what is now called a "half-cell." It deals only with the complete cell. Questions therefore at once arose, for example, with the Daniell cell, "what portion of the potential of the cell arises from the solution of the zinc in the system $Zn:ZnSO_4$, and what portion from the deposition of the copper in the system $Cu:CuSO_4$?" The heat relations were unknown, the reactions were simultaneous, and therefore could not be separately studied.

The first advance along this line was made by Lippmann[20] when he found that "the capillary constant (surface tension, or coefficient of the Laplace formula) at the interface between metallic mercury and dilute sulfuric acid is a continuous function of the e. m. f. of polarization at that surface." The capillary electrometer was the result of these researches. This method gave the first satisfactory process of determining the equivalence of two electromotive forces, and today it is one of the accepted means of measuring potential differences. The piece of apparatus is too well known to require more than a notice in passing. Lippmann did not clearly explain the phenomenon upon which he based his methods.

The first plausible explanation came from Helmholtz in 1879,[21] by what has been known as the theory of the "double-layer." The interface between, say, mercury and dilute sulfuric acid acts as a condenser. The capacity of this condenser system is limited only by the area of the surface of contact, which, in a capillary tube, is very small. The mercury in contact with this dilute sulfuric acid becomes positively charged with respect to the solution; however, according to Faraday's law, no current can flow as long as there is no electrolysis; but that the potential difference exists is known to be a fact. The cause for this is: that at the interface the positive charge in the mercury is exactly counter-balanced by the negative charge in the solution, and, since no current can flow, there is an equilibrium condition

[20] *Pogg. Ann.*, **149**, 546 (1873).
[21] *Wied. Ann.*, **7**, 337 (1879).

set up between the positive and negative charges. The size of these charges regulates the surface tension of the mercury in the capillary tube. Now, if a small current at a small potential is sent through the solution to the mercury, the resulting electrolysis decreases the positive charge on the mercury, which simultaneously increases the surface tension. When there is no charge on the mercury the surface tension assumes its maximum value. According to Helmholtz, this double-layer is at the interface between the solution and the metal, and possesses, for all practical purposes, no thickness whatever. Thus by measuring the capillary rise in the Lippmann apparatus, differences of potential may be measured. However, the values are again only relative.

Further study of the double-layer theory led Helmholtz to make this statement:

> When a quantity of mercury is connected with an electrolyte by a rapidly dropping fine stream of mercury, and is otherwise insulated, these two cannot possess different electrical potentials; for if a potential difference did exist, for example, if the mercury were positive, each falling drop would form an electrical double-layer on its surface, requiring the removal of the positive charge from the mass, and diminishing its positive charge until that of the mercury and the solution reached equality.

The far-reaching application of this statement was not appreciated by Helmholtz, nor by König,[22] until W. Ostwald developed it into another method for determining electrode potentials.[23] The work of König[24] had verified in an excellent manner the theoretical considerations of Helmholtz. Using the same method, Ostwald carried on the work to find how completely the discharge of potential could be carried by using a galvanometer in the circuit. Discordant results forced him to revise the dropping electrode system. With new specifications he was able to measure more accurately these potential differences. The readings of the instrument depend on the cross-section and the form of the capillary. The method depends on the elimination of the potential difference between the mass of mercury and the stream of mercury drops falling into the solution. Now, when zero potential is reached, if an e. m. f. is thrown into the circuit, the potential difference between it and the lower mercury mass can readily be measured, say by the Lippman capillary electrometer. The instrument is known as the "Null Electrode" because during operation it can be held at zero potential.

Ostwald, then, for the first time obtained values of the single electrode potentials. By single-electrode potential is meant the potential difference between a metal electrode and its surrounding solution.

[22] *Wied. Ann.*, **16**, 1 (1882).
[23] *Festschrift d. Polytech. Schule, Riga*, **1887**; *Z. physik. Chem.*, **1**, 583 (1887).
[24] *Loc. cit.*, see footnote 22.

The nature of the metal has great influence on the values of the electrode potential. Zinc and cadmium in all acids investigated become negative, while copper, antimony, tungsten, silver, and mercury become positive; antimony, lead, and iron become positive and also negative from 0.1 to 0.2 volt. Zinc becomes charged —0.7 volt; Cd —0.3; Zn, Fe, Pb ±0.0; Cu +0.3 to 0.4; W +0.4; Sb +0.3; Ag +0.5; Hg +0.8 volt.

The nature of the dissolving acid causes the potential to vary greatly. There is a great difference between the potential in a halhydric acid and in an oxygen acid. Increased dilution causes some positive potentials to decrease, and some negative potentials to increase, but not in all cases, nor with all metals. The potentials of Zn, Fe, and W are changed much by dilution, but with Cd, Pb, Cu, Ag, Hg, only slightly.

These investigations gave no explanation of the origin of the potential. They were concerned with the exact measurement, rather than with the origin. It was left to Nernst, who developed the "osmotic theory" of potential, to find the most satisfactory background for electrode potentials.

Considering the vagueness that surrounded many of the phenomena of electricity and electrochemical actions, it is not astonishing that theories of those early days should be ambiguous and uncertain in the light of present-day knowledge. It is not surprising that Volta believed in the contact theory as the major source of the electric current, because the law of conservation of energy was unrecognized and perpetual motion was considered a possibility of the very near future. Volta was entirely ignorant of the fact that to produce chemical energy it was necessary to degrade other forms of energy.

Without rigid proof, it was clearly erroneous to assume that any reaction which may take place about the electrodes may be a source of electric current and yet, at the same time, that the electromotive force may have its origin in an entirely different portion of the system.

In developing the concept of free energy Helmholtz[25] considered that the free energy was equal to the change in total energy when the change was complete, and none of the changed energy appeared as heat. But, as is usually the case, the free energy was smaller than the total energy change, and the difference appeared as heat, so that the temperature of the system rose. Therefore, vice versa, the temperature of a system dropped when the free energy was greater than the total energy change; and there could be no change in temperature when there was equality between the total and free energy changes.

He assumed also the following:

1. Every (chemical) body or system of bodies possesses a definite quantity of free energy, which is dependent only on the temperature, and on its

[25] Sitzungsber, Berlin, *Akad.*, **2** (Feb., 1882); *Wied. Ann.*, **30**, 401 (1887).

state at the moment (for example, state of aggregation), but is independent of the manner in which this condition is obtained.

2. The maximum work which can be obtained by any isothermal change (chemical reaction, solution, change of state, or capillary surface) is measured by the accompanying decrease in free energy, while the difference from the total energy appears as a maximum amount of heat. Free energy means of chemical substances and systems what potential energy means of mechanical systems.

3. A chemical system is in stable equilibrium only when its free energy is at its smallest possible value at the temperature of the operation. Reaction tends to change a system to its lowest free energy; and when systems are mixed without a reaction taking place, they possess the same free energy.

These are some of the fundamental postulates of the concept of free energy. It was on these assumptions that Helmholtz was able to explain the changes in electromotive force in the calomel cell. When concentrations were changed, the free energy of course changed, and this was made evident by the change in potential of the cell. This idea of concentration change was closely related to the diffusion phenomena in solutions of electrolytes as investigated by Nernst.[26] When a gas is permitted to expand into a larger volume, the process is so very rapid that the system is soon homogeneous. However, in solution, for example, when a pure solvent layer is placed over a layer of solution, a similar diffusion proceeds, in which the solute diffuses from the solution into the pure solvent, but with an almost infinitely slower speed; for the condition of homogeneity to obtain requires days and weeks, where with gases a few seconds is sufficient. The slowness of the process in the solution is due to the interference of the molecules of solvent.

Nernst's contribution to this study was the investigation of the diffusion of different ions, which did not react with each other (one might say indifferent ions). He reasoned that since the ions in solution are individuals, so to speak, and lead separate existences, each ion, according to its kind, must possess individual rates of diffusion. This brings us at once to the conclusion that when an aqueous solution of an electrolyte is over-laid by pure water, there will be a separation of ions in which the more rapidly moving ions out-distance the slower moving individuals. The potentials between different portions of the system must therefore be different. The ions are charged, and, for example, with acids, when the cations migrate much more rapidly than the anion, that portion of the solution into which the hydrogen ions are diffusing with such rapidity must be positive toward that portion of the solution into which the more slowly moving anions are migrating.

[26] *Z. physik. Chem.*, **2**, 613 (1888).

Such is not the whole truth, for as one portion of the system becomes positive with respect to another portion, the diffusion of the hydrogen ions will be depressed by the repulsion of like charges, and the migration of the anions will be increased owing to the repulsion by the negative portion of the solution coupled with an attraction from the positive portion. The net result will be a [somewhat] uniform rate of migration for both anions and cations, so as to insure the electrical neutrality that is demanded by the postulates of the theory of electrolytic dissociation in solution at equilibrium conditions. However, when current is being taken from such a system, the potential differences are due to this differential migration of ions.

The so-called "osmotic theory of potential" which was postulated by Nernst[27] has attracted much attention and a wide acceptance, though in it there is by no means a complete and uniformly accurate explanation of differences of potential. On the face of it, there seems to be much truth in it; but rigorous applications of mathematics and physics lead to rather ridiculous values for some of the physical factors which are utilized in expressing the proposition.

The theory of Arrhenius has been applied by van't Hoff, Ostwald, and, others, merely to a study of the electrical conductivities of solutions and the attending phenomena. Nernst brought the theory into play as an explanation of potential differences; thus opening, clearly and definitely, a new field of relationships.

The system investigated by Nernst in which, for example, a silver plate is immersed in a solution containing silver ions has attracted the most attention in this field. The mathematical equation which was set up is:

$$E = RT \log P/p$$

The factor P is related to the chemical nature of the metal and possesses the dimensions of a pressure, which Nernst has designated as the solution pressure of the metal; p is the osmotic pressure of the silver ions in the solution (in this particular case). Therefore, when the solution pressure P is greater than the osmotic pressure p of the metallic ions in the solution, the potential difference will be in one direction, and when P is smaller than p it will be in the opposite direction. A copper plate immersed in a copper sulfate solution sets up a potential opposite to that obtained from zinc in zinc sulfate.

The calculation of solution pressures, *i. e.*, the values of P, for the various metals from observed potentials, leads at once to pressures which are inconceivably large or small or to the extreme cases. Neumann[28] has calculated some as follows:

[27] *Z. physik. Chem.*, **4**, 129 (1889).

[28] See Jahn, "*Grundriss der Elektrochemie*," Wien, **1895**, p. 195.

$$\begin{aligned} \text{Zn} &= 2.7 \times 10^{19} \text{ atmospheres} \\ \text{Cd} &= 7.4 \times 10^{6} \text{ atmospheres} \\ \text{Tl} &= 2.1 \times 10^{3} \text{ atmospheres} \end{aligned}$$

and even larger values for the alkali metals; while for the noble metals such values as 10^{-36} atmospheres for Pd are obtained.[29]

Whether or not such values are meaningless is beside the question, but they have thrown some discredit on the theory of Nernst so that the concept of solution pressure has been eliminated from the equation, which now is usually written:

$$E = E_0 + RT \log C$$

in which E_0 is the normal electrode potential, *i. e.*, the electrode potential in a solution normal in cations of the metal in question, and C is the concentration of the cations in the solution being studied at the time.[30]

This Nernst concept has been applied with great success to the calculation of the potential differences between solutions of different concentrations, and to all other systems in which potential differences may be developed. However, that it is not wholly correct nor wholly acceptable need cause no serious worry. The theory has given a clearer insight into the problems of electrode potential, which is a most valuable contribution.

[29] Lehfeld, *Phil. Mag.* (5) **48,** 430 (1899).

[30] See Butler, *Trans. Faraday Soc.*, **19,** 729 (1924), and Rideal, *Ibid.*, 667, for a recent discussion of the Nernst equation, etc.

Traces of Nickel Found in Foods. Traces of nickel have been found in several human foods by Prof. Hans Kaufmann and Prof. Oskar Keller, of the Pharmaceutical Institute of the University of Jena. The amounts are expressible only in millionths of a per cent by weight, but may be of medical significance, since nickel is usually considered an element deleterious to human health, which must be eliminated from the system. However, if minute amounts of certain metals are needed by all animal tissues, as some chemists claim, this may be the source for the body's nickel supply.

The two German chemists were led to their researches by the question of the possible harmfulness of nickel in margarine. This food fat is made by passing hydrogen through vegetable oils, in the presence of finely divided nickel which serves as a catalyst or chemical matchmaker to secure the union of the hydrogen and the oils. By testing high-grade margarine with the most delicate of known chemical methods, percentages of nickel from five ten-millionths to one millionth by weight were detected.

But when the experimenters turned their attention to butter, they were surprised to find that good grades of this product contained more nickel than was in their margarine samples. They then analyzed various fodders eaten by cows, and again found nickel.

The highest concentrations of nickel in plants were found in the legume, or pea family. Peas and beans showed percentages as high as two hundred-thousandths.—*Science Service*

THE R. E. OLDS SCIENCE HALL AT KALAMAZOO COLLEGE

WARREN C. JOHNSON, THE UNIVERSITY OF CHICAGO, CHICAGO, ILLINOIS

It is well known that most of our higher institutions of learning depend upon the numerous small colleges throughout the country for many of their graduate students in the sciences. If we were to examine the training of these students as undergraduates we would find that, in most instances, they were trained in departments consisting of a very limited number of instructors. Likewise, we would find that the physical equipment was usually inadequate, at least far inferior to that of our universities. Although the small college is handicapped by these disadvantages, nevertheless, it continues to supply students for graduate training These students have received the individual attention and inspiration of their instructors and before they reach the graduate school have obtained somewhat of a scientific point of view. It is not to be disputed that the addition of staff and equipment to the smaller institutions will have a pronounced effect upon the quality of graduate students.

PROFESSOR L. F. SMITH

During the past fifteen years Kalamazoo College has contributed a relatively large number of students to the graduate schools of chemistry. Twenty graduates have completed their work at various universities for the degree of Ph.D., twenty-one (exclusive of the above number) have received the Master's Degree, and seven are now candidates for the latter degree. Many students of the two latter groups are now continuing their work for the Ph.D. degree. These forty-eight students have graduated from Kalamazoo College in the years 1913–28 during which period the average graduating class of the college numbers about 45 students. Thus an average of more than three students per year have pursued graduate work in chemistry for the higher degrees. During the past five years this average has been higher, about ten per cent of the students of each graduating class having followed chemistry in graduate schools.

This fine record is due to Professor L. F. Smith who has interested students in his courses and has given them an appreciation of the science of chemistry. Until the past year Professor Smith presented all of the courses of instruction in chemistry.[1] The proof of Professor Smith's inspiration and teaching ability lies in the fact that the students who have left him to carry out graduate work occupy today responsible positions in many of

[1] Dr. Allen B. Stowe has recently been added to the Department as Professor of Physical Chemistry.

our colleges and universities as well as in many of our progressive industrial establishments.

Dr. R. E. Olds, of Lansing, Michigan, a pioneer in the automobile industry, recognizing the invaluable work being carried out at his Alma Mater under extremely limited conditions, planned a new laboratory for physics and chemistry. No other gift could have been more appropriate at this time. The construction of the laboratory was completed in the spring of 1928 and was occupied by the two departments the following fall.

R. E. OLDS

The R. E. Olds Science Hall is of fireproof construction, 120 × 62 feet, the exterior of tapestry brick with limestone trim, the floors, hallways, and stairs all of reënforced concrete.

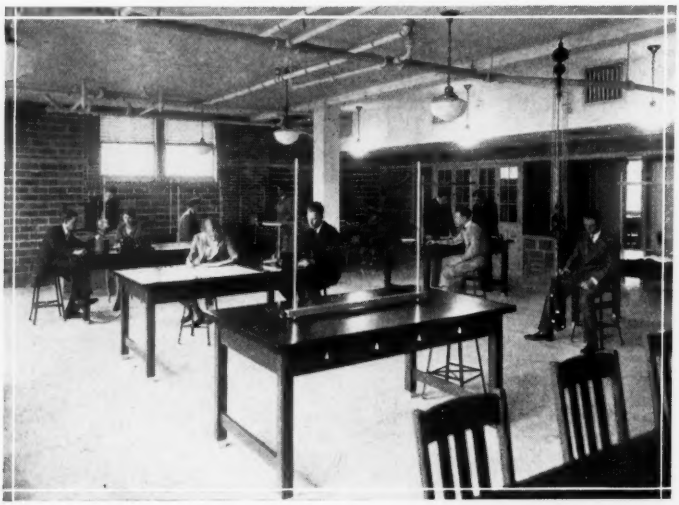
In the basement are several storage rooms, the boiler room, and a machine shop. There are no laboratories in the basement. The first floor is given over entirely to the department of physics. This includes a lecture room seating 63 students, office, seminar room and library, general physics laboratory, electrical measurements

R. E. OLDS SCIENCE HALL

laboratory, photometry and optics laboratory, and two research laboratories. A number of piers are distributed throughout the laboratories.

The second and third floors are devoted to chemistry. Most of the laboratories for advanced students are on the second floor, including those of physical chemistry and quantitative analysis, as well as five private laboratories, a research laboratory, a balance room, the departmental library, and a lecture room seating 140 students. On the third floor, besides the usual stock rooms and balance room, are the general laboratories for inorganic, organic, and qualitative analysis.

The general chemistry laboratory is located on the third floor occupying half of the entire floor space. There are ten oak-finished laboratory tables

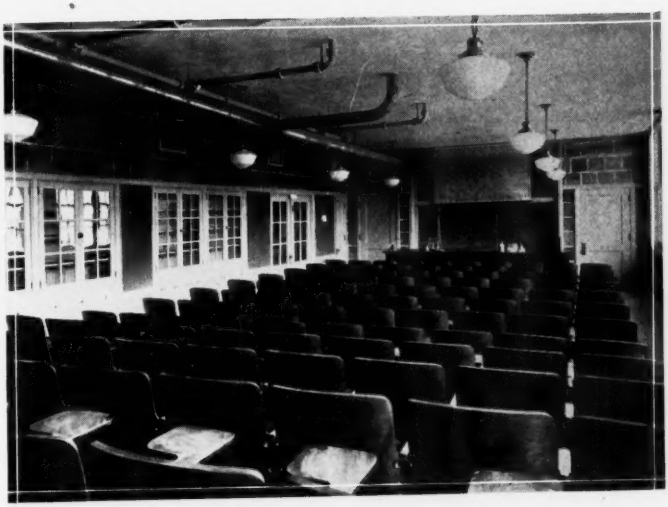


GENERAL PHYSICS LABORATORY

with oil-rubbed Alberene stone tops at which 80 students are able to work at one time without interfering with one another. Each table is equipped with two sinks, attachments for condensers, vacuum pumps, gas, water, contacts for electricity, and hoods. Individual lockers for apparatus and glassware are provided for the students. There are also five wall hoods with sliding glass panels which are equipped with hydrogen sulfide gas, illuminating gas, steam, vacuum pumps, water, and electricity. Along the sides of the room are six tables supplied with compressed air and gas for blast lamps. Adjoining the laboratory is the balance room with several high-grade balances mounted on concrete piers.

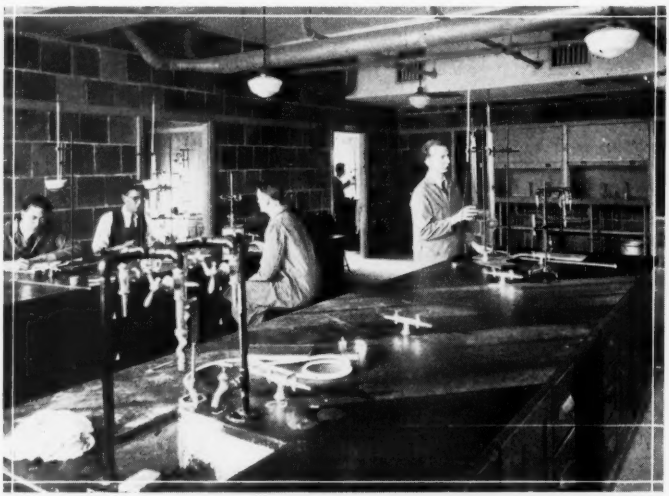
The general chemistry lecture room has a seating capacity of 140 in

General Chemistry Laboratory



Chemistry Lecture Room

comfortable auditorium chairs with folding desk arms. The entire south wall of the room is made up of glassed-in show cases with considerable drawer capacity below. Windows run the entire length of the room on the north side. Blackboard space is provided for on the back wall and on three sliding boards behind the lecture table in the front of the room. Heavy shades may be drawn so as to darken the room for the use of motion pictures and lantern slides. The lecture table is similar to those used in the laboratories with the additional advantage of direct current contacts. A preparation room directly adjoins the lecture room.



PHYSICAL CHEMISTRY LABORATORY

The organic and qualitative analysis laboratory is slightly smaller than the general chemistry room. There are six oak-finished laboratory tables with Alberene stone tops enabling 48 students to work at one time. The tables are equipped similarly to those of the general chemistry laboratory. On one side of the room are four wall hoods equipped in the same manner as the previously described hoods. A stock room specially for organic and qualitative analysis experiments occupies a room adjoining the laboratory.

The laboratories of physical chemistry consist of one medium-sized room for the general laboratory work, three smaller laboratories, opening off the larger room, for individual work in special phases of physical chemistry, a stock room, and a dark room. Each of the laboratories is equipped with

a ventilating hood, gas, water, compressed air, steam, hydrogen sulfide gas, and both alternating and direct current electricity.

In addition to the usual equipment these laboratories are supplied with the following high-grade pieces of apparatus: An Abbé refractometer, Leeds and Northrup galvanometers and resistance boxes, a Leeds and Northrup Type K potentiometer, a Kohlrausch circular slide wire, conductivity cells of various types, Weston ammeters and voltmeters, Epply standard cells, a Freas constant temperature thermostat bath, a Clark shaking type electrode assembly, Vreeland Oscillator, a Cenco Hyvac pump, Kraus mercury vapor vacuum pumps, a Toepler pump, a McLeod gage, apparatus for molecular weight determinations by the standard methods, a Gaertner spectroscope, electric furnaces, a Schmidt and Haensch polariscope, a Spencer chemical microscope, laboratory motors, Du Nouy precision tensiometer, a Parr adiabatic oxygen bomb calorimeter, Bausch and Lomb colorimeter, and a Kelvinator electric refrigerator.

Conveniently located near these laboratories are those of quantitative analysis, the combustion room, and the balance room. The equipment in these rooms include high-grade analytical balances, electric water baths, a Freas electric oven, an electric muffle furnace, an electric multiple unit combustion furnace, complete gas analysis apparatus, a Freas electric Carius tube furnace, and Kjeldahl nitrogen determination apparatus.

The R. E. Olds Science Hall was dedicated June 13, 1928, as part of the commencement program. Dr. Charles A. Kraus, research professor of chemistry, Brown University, presented the dedication address, "The College and the University," which address directly follows this article.

Japanese Drug and Medicinal Exports for 1928. Chemicals, drugs, and medicines exported from Japan during 1928 amounted to approximately 21,000,000 yen (approximately $10,500,000), according to the Ministry of Finance. The largest item, pyrethrum, or insect powder, was valued at 7,487,675 yen, doubling that for 1927. Next came camphor, totaling 5,447,522 yen, a decrease of 190,210 yen on the previous year. The export value of the leading articles during 1928 was as follows:

	Yen
Camphor Oil	1,003,019
Peppermint Oil	2,075,890
Ginseng	251,519
Pyrethrum	7,487,675
Camphor	5,447,522
Menthol, Crystal	3,914,516
Menthol	178,680
Iodine	412,670

Chem. Age, **20**, 448 (May 11, 1929).

THE COLLEGE AND THE UNIVERSITY*

CHARLES A. KRAUS, BROWN UNIVERSITY, PROVIDENCE, RHODE ISLAND

I am aware that, in choosing a subject for discussion this morning, I have departed from established practice; for, when a chemist speaks to a lay audience, it seems to be expected that he will dilate on the wonderful developments of his science and on its applications in particular. I am going to assume that my audience, today, is familar with the applications of science and shall attempt to discuss some problems that are of more immediate concern to our educational institutions, and especially such problems as have a bearing on the development of scientific thought in these institutions.

It is now well recognized that the results of scientific investigation are often directly applicable in the solution of many important practical problems, and that the applications of science in the arts and industries are profitable as well as practicable. The general recognition of the practical applicability of science in a commercial way has revolutionized our mode of thought and our method of approach to most of the problems of life.

Every application of science carries in its wake still other changes. The resultant effects are cumulative, and physical progress proceeds with ever greater and greater acceleration. It becomes increasingly difficult to foresee what will be the consequences of the applications of science in the future and it becomes increasingly important to foresee what these consequences will be in so far as this is possible.

In order to arrive at a proper evaluation of this problem, it is necessary to take into account the human factor, the individuals in whose minds the future developments of science must be worked out. As the applications of science increase in number and variety, there arises an increased demand for men who are qualified to undertake and guide these developments; and it is the function of the college and university to furnish an adequate supply of men who are thoroughly qualified to solve the problems incident to our ever-expanding civilization. At the same time, we must expect that in the future, as in the past, the colleges and universities will serve as centers of scientific thought where new discoveries are made and the ground is broken for future progress. It is for this reason that I have felt free to choose as a subject for discussion, not the immediate applications of science, but, rather, the interaction between the applications of science and our educational institutions.

Although the fact is not obvious on the surface, the development of science and its applications is exerting a tremendous influence on our educational institutions and on our educational methods. This has resulted, in the first

* Dedicatory address delivered June 13, 1928, at R. E. Olds Science Hall, Kalamazoo College, Kalamazoo, Michigan.

place, in an enormous increase in the number of students registered in our colleges and universities and, in the second place, on the nature and extent of the work that the student is expected to take as a preparation for practical life. Were it not for the great developments of science, our traditional four-year college course would, doubtless, still be substantially adequate for our needs. But, now, we find that in the sciences, at any rate, the period of training must be increased from four to seven years and even this seems scarcely adequate. We find, too, that the quality of the material must be selected with greater care than heretofore, and that only such students should be encouraged to proceed with the study of the sciences as are especially qualified therefor. In a sense, the sciences have taken the lead in solving our modern educational problems. While honors courses and individual instruction are only now finding their way slowly into those subjects which are commonly classified under the humanities, the equivalent of such courses has long been common practice in the sciences. I venture to predict that many of our educational problems will find their solutions first in the scientific departments.

The irresistible pressure of our physical surroundings on educational practice has not only led to an enormous increase in the number of students and to a lengthening of the period of training, it has also led to a profound change in the whole scheme of higher education. This is reflected in the chaotic state of the relations of the various units of our educational system to one another. At the present time, in addition to the old type of college, high school, and academy, we have junior high schools, senior high schools, junior colleges, senior colleges, and, perhaps, universities. It is not altogether clear what will be the outcome of the present educational revolution, but it is safe to predict that our educational system must ultimately shape itself in such a way that it will meet the needs of the time with a minimum wastage of human material. It can be clearly foreseen that men who are thoroughly qualified and adequately trained in the sciences must be supplied in ever-increasing numbers in order to meet the needs of present and future industrial developments.

It may be anticipated that in the future almost every step forward in civilization will follow only as a consequence of an advance in science or its application, and every development in science necessarily carries others in its train. As our population increases and the individual needs of the population increase, many new problems present themselves and these problems must be solved successfully if progress is to continue. In the final analysis, the major problems relate to supplying the ultimate necessities of life. While such problems have a profound political and sociological bearing, it does not appear that they can be solved merely by political or sociological methods. Science, only, can solve such problems and it is one of the prime functions of the politician and the sociologist to

provide the scientist with the opportunity to devote his energies to their solution.

Let me illustrate by an example what I mean by a major problem. Thirty years ago Sir William Crookes, at a meeting of the British Association in Bristol, called attention to the diminishing supply of foods in relation to increasing population. He pointed out that the continuous production of food involved the ultimate exhaustion of the soil and a diminution of the food supply unless this exhaustion was compensated by replacement of the essential soil elements by means of artificial fertilizers. One of the most important soil constituents is nitrogen in combination with other elements, or "fixed nitrogen," as it is called. While nitrogen compounds are supplied slowly to the soil by natural processes, the rate of supply is far too slow to permit of the continuous growth of crops. Nitrogen, suitable for fertilizer purposes, occurs in nature only in very limited quantity, chiefly as sodium nitrate or Chile saltpeter in the arid regions of Chile and Peru. Thirty years ago, it seemed that the supply of natural nitrates would be exhausted in the course of from thirty to fifty years, and we now know that this estimate was not far wrong. As Crookes pointed out, if the food supply of the world was to be assured, it was necessary to devise means for producing the nitrogen compounds, or fixed nitrogen, in suitable form for use as fertilizer from the nitrogen of the atmosphere.

As you doubtless know, approximately 80% of the atmosphere consists of nitrogen, but in order to make this nitrogen available as a food for plants, it is necessary to combine it with other elements. That such combination is possible, was demonstrated by chemists more than a hundred years ago but to accomplish this result in a practical way, that is, at a reasonably low cost, further developments were required. I need not go into the details of the experimental and theoretical work which finally led to the solution of the nitrogen problem. Suffice it to say that, today, atmospheric nitrogen is being combined with other elements on a commercial scale in nearly every civilized country and that ammonia and nitrates are synthesized at a cost that makes us quite independent of natural supplies of sodium nitrate. Every year thousands of tons of atmospheric nitrogen are being fixed and placed on the market at figures that are astonishingly low. In less than a quarter of a century the nitrogen problem was solved and with it was solved the great problem of food supply for the ever-growing world population.

As time goes on, other problems will appear. It seems fairly certain that the world supply of oil for automotive and other purposes is limited and that exhaustion of this supply is remotely in sight. Indeed, were it not for the introduction of new and improved methods for obtaining gasoline from crude oil, we should probably be facing a shortage at the present time. The possible exhaustion of our natural oil supply would constitute a most

serious problem were it not that the solution of this problem is already in sight. Here, again, the applications of science promise a successful solution of the problem before serious need has arisen. Numerous methods have been devised and are gradually being developed whereby suitable automotive fuels may be obtained from coals or from other sources.

While, at the present moment, there is no major problem whose solution is not in sight, it must be anticipated that, as time goes on, problems of this kind will appear with increasing frequency and that they will be increasingly difficult of solution. It is one of the primary functions of our educational institutions to supply the means for solving the problems that arise as society develops.

As thinking men, we cannot but ask ourselves the question: How shall we prepare ourselves to solve these major problems as they arise? Since these problems are largely physical in nature, it may be anticipated that their solution may be arrived at through the application of scientific principles. In order to be prepared to solve those problems, then, we shall have to promote science. Now we may obviously promote science by multiplying the number of scientific laboratories and building up their equipment. And we can place in these laboratories the best trained scientists that are available and supply them with every means for research. Yet, I venture to say that this method of promoting science will not prove successful in the long run.

The physical plant and all that goes with it is merely an adjunct to scientific investigation, for, after all, research is a mental process rather than a physical operation and the primary factor in connection with all scientific problems is the human element. While a laboratory may be built and equipped in a year or two, the training of an investigator requires a quarter of a century. And, at best, under given conditions, the number of men who are competent to carry on investigations of a high order is strictly limited. If we are to solve successfully the various physical problems as they arise, it will be necessary to train, beforehand, the men who are to accomplish such solutions. It is the chief function of the colleges and the universities to select and train the men who are to develop science to meet the future needs of our civilization.

The qualities essential in one who is to develop science successfully are numerous and exacting and only a limited number of the men who come to the colleges and universities meet the necessary requirements. These qualities, moreover, are in a large measure innate and cannot be supplied by training. With a constant and growing demand for men who are qualified to undertake scientific work, it is becoming increasingly important to find an adequate supply of material. While it is becoming increasingly necessary that the colleges and universities shall reach, among their student body, all those who are qualified to carry on scientific work, it is

also necessary that the colleges and the universities shall not attempt to train as scientists men who, by nature, are not equipped for scientific careers. Having found men fitted for scientific pursuits, the colleges and the universities must provide adequate facilities for training them so that they may be prepared for the tasks that lie before them. Such training must be of the highest quality; and, above all, it must be such as serves to develop independence of thought and individuality of action. Such training can be imparted only by individual instruction. The training of scientists by methods of mass production is foredoomed to failure. We have all too little material for our present needs and we can ill afford to stunt the development and repress the individuality of those men who must act as leaders of thought within the next generation.

Because of the large number of students in our colleges and universities, the methods of mass production have long been practiced in the undergraduate field. The rapid development of science in this country during the past quarter of a century has led to an enormous increase in the number of students in our graduate schools, particularly in the sciences. We find many university departments over-crowded with students and there is discernible a tendency to make the requirements for higher degrees more and more mechanical. A university can perform its functions successfully only if the instruction given its students is individual. It is of primary importance that, in a university, a graduate student shall be treated as an individual and not as one of a collection. The needs, abilities, and qualifications of every student must be carefully gaged and his course of training must be adjusted to meet his individual requirements.

Indeed, it would seem that not only must we individualize instruction in the universities, but we must carry the same methods over into the college. Whether this will ever be possible in our larger undergraduate institutions is perhaps open to question, but there certainly is no reason why this method is not practicable in our smaller colleges. It would seem that, at the present moment, the smaller colleges have a unique opportunity to develop methods of instruction in the sciences, as perhaps also in other subjects, which shall be superior to those practiced in the larger universities. I am convinced that the smaller colleges have here a rare opportunity for leadership which is not readily open to the larger institutions.

I shall not venture to suggest how the larger institutions may meet this particular problem. Since they appear to have a superabundance of human material, they may, perhaps, feel that they are able to draw from their undergraduate student body a sufficient supply of material for the needs of their graduate schools. Yet, in the long run, such a wasteful method cannot be tolerated. The available supply of human material is already none too plentiful and, as time goes on, it will become increasingly

necessary to utilize this material to its fullest extent and our educational methods will have to be adapted to accomplish this. It may be that, with the introduction of the junior colleges, there will be some diminution in the number of students in our universities and a consequent improvement in their training, but, on the whole, the indications are that the number of students in the senior colleges will increase rather than decrease. It seems almost as though it would be necessary to break up our larger institutions into a number of smaller units. This would naturally entail an increase in the cost of education and a practical step in that direction is not to be looked for unless the necessity for such action is clearly demonstrated.

If the smaller colleges, working with a smaller number of students, who have been more carefully selected with a view to their abilities and objectives, and who are more carefully trained with a view to the development of individual abilities, can demonstrate the superiority of their products, then the larger institutions will necessarily have to follow suit.

What I should like to propose as a solution for our higher educational problems is contrary to what seems to be the trend at the present moment. As I see it, the tendency in the larger universities now is to eliminate the first two years of college work, transferring them to junior colleges. At the same time, the number of students in the junior and senior years and in the graduate school will remain unchanged or be increased. This number will certainly be so large that mass methods will still be employed. There arises, too, the question whether the junior college can maintain and advance the standards of instruction. Rather than to bar freshmen and sophomore students forever from the university atmosphere, I should like to propose that the university method, that is, the method of individual instruction of selected students, be carried into the colleges. It is certainly applicable in the last two years of college work and I should be greatly surprised if it could not be extended into the earlier years.

The successful operation of this method in the colleges naturally requires adequate physical equipment. It also requires a staff which combines teaching ability with scientific insight. To my mind, it is highly desirable that our college faculties should include men who are in sufficiently intimate contact with science, by way of research or otherwise, so that they are fitted to impart to their students the scientific point of view and the enthusiasm that goes with scientific accomplishment. If a student is to be successful in science, he must have acquired the scientific point of view long before he reaches the graduate school. And, unless our graduate schools are supplied with students who already have acquired the habit of scientific thought, they will of necessity become even more mechanical than they are now.

AN EXPERIMENT IN CHEMICAL EDUCATION AT YALE

JOHN A. TIMM, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

The need of a course in chemistry, designed especially for those students whose major interests lie elsewhere, has long been felt by many of us who have been teaching elementary chemistry courses. The cultural value of the methodology and philosophy of science in general and of chemistry in particular to a student of the classics or the humanities is unquestioned. That this value is often lacking for him in the more or less traditional type of *elementary* chemistry course is only too evident from the results which this type of course has produced with this kind of student. The presentation of the properties of one element and its compounds after another and the drill in equation writing and problem solving, necessary and desirable though these may be for the student who plans to major in chemistry, have no place in such a cultural course. The development of a certain degree of mental dexterity in handling the tools of the science represents a cruel waste of time for the student who is specializing in other fields.

Pandemic Chemistry

In 1926 Bancroft[1] of Cornell proposed the name *pandemic chemistry* for a course designed to meet the needs of students of this type. His conception of the nature of such a course was embodied in an outline of lecture topics, which were in the main on the applications of chemistry. Professor Bancroft says in this paper:

> It is evident that a course such as outlined will not teach a student any chemistry to speak of. It is not intended to; but it will teach him *about* chemistry and it will give him an interest in chemistry which will stay by him throughout life.

Recently Sampey[2] of Howard College has outlined a course of the same name and of much the same nature in a paper in which he says:

> The most obvious objection raised by the teacher trained in the present system is, how can we teach the *applications* of chemistry to industry and life before the student receives the foundations of *theoretical chemistry?* That is the major difficulty and the one we have faced squarely in all our experiments in pandemic chemistry.

There has grown up, therefore, about the excellent name, *pandemic chemistry*, the idea of a chemistry course devoid of theory but full of applications. This the writer considers unfortunate, since in the course which he has developed at Yale to meet the same need the emphasis is reversed. A course in the philosophy of chemistry would more accurately describe

[1] W. D. Bancroft, THIS JOURNAL, **3**, 396 (Apr., 1926).
[2] Sampey, *Ibid.*, **5**, 1243 (Oct., 1928).

the Yale course but the term *philosophy* is so high-sounding that one hesitates to adopt it.

The History of the Course

In 1925 the Board of Permanent Officers of Yale College[3] requested the chemistry department to offer a new course in chemistry designed primarily to meet the needs of its students. The writer was given by the chemistry department the task of developing and teaching this course. It was first offered in 1926–27 and was elected by 35 students; the following year by 55 and at present 115 undergraduates are taking the course. Next year we shall have 180 students. Although it is primarily a Yale College course, many students in the Sheffield Scientific School have elected it with the approval of their dean.

The Objectives of the Course

In outlining the subject matter of the course, the following objectives were kept constantly in mind:

First—to develop an appreciation of the scientific procedure as it has been applied in the derivation and testing of the fundamental theories of the physical sciences; that is, of the way in which data are collected and classified, of the process of analysis or reduction to simpler terms, of the setting up, testing, and modification of one hypothesis after another until, finally, a general formula or law of nature is discovered.

Second—to teach how the results of research are published, abstracted, tabulated, and finally brought together in the form of scientific monographs or textbooks; and how to use this literature for the acquisition of scientific information.

Third—to give a knowledge of the application of these theories to the development of natural resources, to the problems of industry and to those of daily life of the individual.

Fourth—to treat the development of the theory from an historical point of view in so far as is consistent with a presentation of the subject matter which is pedagogically sound.

On the other hand we were firmly convinced that the order of presentation should not be based on a study of the descriptive chemistry of the elements and of their compounds, but that a logical development of the philosophy of the science should determine the order of presentation. We were also convinced that specific descriptive material should be introduced only as needed in the development and critical inspection of the theory. We were further persuaded that drill in handling the tools of the science (*e. g.*, equations) should have no place in the course. With these objectives and convictions in mind we proceeded to outline the course.

[3] The undergraduate school in the liberal arts of Yale University.

General Outline of the Course

THE NATURE OF MATTER.

a. *The Kinds of Matter*—Mixtures, solutions, elements, and compounds.
b. *The Nature of Gases*—Development of the kinetic-molecular theory of the structure of gases from the behavior of the perfect gas as stated by the gas laws. Deviations from the gas laws and their explanation.
c. *The Nature of Liquids*—Structure of liquids. Evaporation and vapor pressure. Physical equilibrium and van't Hoff's law.
d. *The Nature of Solids*—Crystal forms and structure.
e. *Changes of State*—Freezing, melting, and boiling. Condensation of vapors. Critical phenomena. Liquefaction of gases and artificial refrigeration.
f. *Molecules*—Size. Motion. Molecular weights. Mole. Avogadro's hypothesis. Molecular weight determination. Avogadro's number.
g. *Atoms*—Derivation of Dalton's atomic theory from the laws of definite composition, combining weights, and multiple proportions. Relationship of atoms to molecules. Atomic weights and their determination.
h. *The Shorthand of Chemistry*—Symbols and formulas. Derivation of formulas. The classical idea of valence. The use of valence.
i. *The Periodic Law.*
j. *Sub-Atomic Phenomena*—The determination of the charge and of the mass of the electron.
k. *The Structure of the Atom*—Work of Moseley. Rutherford's nuclear atom. The contents of the nucleus and the number of planetary electrons in the neutral atom.
l. *Radioactivity.*

THE NATURE OF ENERGY.

a. *The Forms of Energy*—History of the development of the concept of energy. The law of conservation of energy. The forms of energy.
b. *The Nature of Heat*—The uniquity of heat energy. The convertibility of heat into other forms of energy. The nature of heat energy. Temperature. The availability of heat energy.
c. *Radiant Energy*—Properties of light. The wave theory. The complete electromagnetic spectrum. The modes of generation of light of various frequencies.
d. *Spectra*—The continuous, band, bright line and absorption spectra. Spectroscopy. The Balmer formula. The quantum theory.
e. *The Bohr Theory of the Arrangement of the Planetary Electrons*—The nature of valence. Positive and negative valence.

THE NATURE OF CHEMICAL REACTIONS.

Nature. Equations. Types. Factors influencing rate.

THE NATURE OF COMBUSTION.

Our fuel resources.

THE CORROSION OF METALS.

a. Their relative activity.
b. Oxidation-reduction.

METALLURGY.

a. In general.
b. Of iron and steel.

SOLUTIONS.

TWO COMPONENT SYSTEMS AND THE STUDY OF ALLOYS.

COLLOIDS.

CHEMICAL EQUILIBRIUM.

THE THEORY OF IONIZATION.
ACIDS, BASES, AND SALTS.
REACTIONS BETWEEN ELECTROLYTES.
- *a.* Neutralization and precipitation.
- *b.* Hydrolysis.
- *c.* The philosophy of analytical chemistry.

THE HEAVY CHEMICAL INDUSTRIES.
- *a.* Sulfuric acid.
- *b.* Nitric acid—fixation. The effect of pressure and temperature changes and of catalysts on chemical equilibria.
- *c.* Soda, lime, and caustic soda.

ELECTROLYSIS AND THE ELECTRO-CHEMICAL INDUSTRIES.
ELECTRO-CHEMICAL CELLS.
CROPS AND THE SOIL.
THE FERTILIZER INDUSTRY.
THE NATURE OF ORGANIC COMPOUNDS.
- *a.* The hydrocarbons.
- *b.* Alcohols and ethers.
- *c.* Aldehydes and ketones.
- *d.* Carbohydrates—the sugar and cellulose industries.
- *e.* Acids and esters—fats and soap.
- *f.* Amines, amides, and proteins.

THE CHEMISTRY OF FOOD AND NUTRITION.
Enzymes and digestion. Fate of foodstuffs in metabolism. Fuel value of foods. Energy requirements. Vitamins. Best use of foods.
COAL TAR AND ITS DISTILLATION PRODUCTS.
EXPLOSIVES.
DYES.
CONTRIBUTIONS OF CHEMISTRY TO MEDICINE.

Textbooks and Collateral Reading

As might be expected, no textbook could be found which could be used in this course. However, the students are required to purchase "Atoms and Electrons," by J. W. N. Sullivan (Doran), the two volumes of "Chemistry in Industry" and "Chemistry in Agriculture." Required reading is assigned from time to time in these books. In addition numerous references are given to standard chemistry texts, to books of a popular nature on chemistry and physics and to papers in the chemical literature. A shelf of books is reserved in the university library to which they are constantly referred. Once a term each student is required to write an essay of some two thousand words on a topic of his own choosing, which has either been mentioned in the lectures or suggested by the lecture material. In the preparation of material from these essays, the student must find his own references.

A text is in preparation for the course and will be used in a mimeographed form next year. It will be published for general use the following year.

At present the course is given in three lectures a week. However, when the text is published, only two lectures a week will be needed. The third

period will be devoted to discussion sections of not more than twenty men in a group.

Laboratory

The writer is not at all convinced of the value of including a laboratory period in a course of this type. Unquestionably, the students are benefited by it but there is always the possibility that time given to group discussion might be of greater value to this type of student. Be that as it may, a laboratory period of two hours a week is included in the course as given at present. An effort has been made to get away in so far as possible from the traditional cook-book type of laboratory directions; to give more exercises of the simple problem type; and to train the student to carry out quantitative experiments.

* * * * *

In the near future the writer plans to publish a paper in THIS JOURNAL in which the subject matter of the lectures and the laboratory experiments shall be discussed in greater detail.

The Copper Situation in Canada. The discovery of important copper deposits in the Rouyn area of Western Quebec; at the Frood and Frood Extension copper-nickel mines and at the Errington zinc-copper mine in the Sudbury district, Ontario; the successful development work in progress at the Flin Flon and Sherritt-Gordon mines in the Pas district, northern Manitoba; the additions to plant equipment at Anyox, Britannia Beach, and Copper Mountain; and the successful results obtained at the Coast Copper property on Quatsino Sound in British Columbia, are all new factors likely to make a substantial increase to the Canadian production of copper. The completion of the Noranda smelter in the Rouyn area has raised Quebec to the rank of an important producer. One unit only of the smelter, originally designed for treating 500 tons of ore per day, has already reached a capacity of nearly 1000 tons. The very successful development campaign of the International Nickel Co. at the Frood mine and that of the Mond Nickel Co. at its Frood Extension mine, have opened up enormous reserves of good grade copper-nickel ore. The International is also proceeding with the erection at Copper Cliff of a large concentrator and a new 4000-ton copper smelter, which will be supplemented with a copper refinery, probably to be located at Port Colborne.

The Errington zinc-copper mine near Sudbury has been proceeding with its development campaign. At the Flin Flon property in northern Manitoba the ore reserves are estimated at 16,000,000 tons to a depth of 900 feet. The ore body averages 1.7 per cent copper and 3.5 per cent zinc, with low values in gold and silver. Results at the Sherritt-Gordon have been very encouraging, and the property is being actively developed. The ore zone has been traced for several miles and two ore bodies definitely proved. Of these the eastern is said to contain 2,000,000 tons and the western 3,000,000 tons to a depth of 500 feet. The average assay of the ore has been given as: copper, 2.3 per cent, zinc 5.9 per cent, with small amounts of gold and silver. Important new developments are reported from British Columbia at some of the producing properties and new discoveries are also reported. The prevailing low price of copper during the past few years has been offset to some extent by improved methods of concentration and metallurgical treatment.—*Chem. Age* (*Mo. Met. Section*), **20,** 40 (May 4, 1929).

TESTING LABORATORY TECHNIC IN HIGH-SCHOOL CHEMISTRY

KIMBER M. PERSING, GLENVILLE HIGH SCHOOL, CLEVELAND, OHIO

The present study was planned and set up in an attempt to measure the achievement of high-school chemistry students in laboratory technic. This made it necessary to build an objective test for, at present, the achievement tests are almost entirely concerned with the text content of the course of study. Several questions were considered in laying out the work. What does the present program of laboratory work in chemistry contribute to the achievement in chemistry? To what extent is the achievement in the laboratory phase of chemistry comparable to the achievement in the classroom work? It was hoped that data secured in making a study of this kind might be valuable in working out a more accurate means of evaluating the work of the student.

The method of study followed in this investigation may be briefly outlined as follows. A test was constructed and administered to students who had completed one year's work in high-school chemistry. The test consisted of items selected from the laboratory work, usually included in a high-school course of study. The test was given by the instructor during a regular class period. The papers were then corrected from a key by each instructor, who tabulated the results and returned them to the writer.

The Test

The work of constructing a test presented some difficulties. In order to measure and evaluate the results of laboratory practice, it seemed best to build a test that would most nearly reproduce the situations which the students have experienced in actual laboratory practice. To do this, the test items were written in the form of problems, each illustrated with a drawing which would represent the conditions discussed in the problem, or show the difficulty encountered.

The initial test consisted of ten or twelve items mimeographed and used in the writer's classes. The results were then tabulated and used in preparing a revised form, which was used in 1926 in testing about 200 students. On the basis of the results now available a more extensive test was constructed. This form, used in 1927, was given to 535 students, representing ten high schools.

The final form of the test was constructed for use in the spring semester of 1928. The test in two forms consisted of 80 items each. The two forms were essentially alike, the problems used involving the same principles but applied through different material. This form required about 40 minutes to administer although a few students found some difficulty in completing the test in that time.

The selection of material, representative of a typical course in laboratory chemistry, was one of the major problems. In order that the material used would be representative of a fair sampling, all available laboratory manuals were consulted. In the final checking, all items were rejected which were not treated in all the manuals. A summary of the source materials is as follows:

1. *Laboratory Manuals:* a careful study was made selecting material common to all.
2. *The College Entrance Examination Board:* "A Proposed Definition of High-School Chemistry."
3. *American Chemical Society:* "A Standard Minimum High-School Course in Chemistry."
4. *Teacher Suggestions:* problems involving principles and practices.
5. *Completion of Apparatus:* problems in completing various types of apparatus.
6. *Courses of Study.*
7. *Difficulties:* a group of problems selected from the incorrectly set up apparatus which is found in high-school laboratory work.

The test, as mentioned above, was prepared in mimeographed form. The drawings were prepared with as much accuracy as is possible in a mimeographed reproduction and served the purpose very well. The extended use of illustrations prevents the printing of the entire test in this report, but a few typical questions will serve to illustrate the type of problem and show the general mechanics of the test. These sample test questions are given below.

The extent to which the test covered the laboratory phase of the high-school course in chemistry may be estimated by considering the analysis of the test which follows. A summary of the facts included in the problems shows the following content.

1. *Filtering:* recognition of "filtrate" and "precipitate."
2. *Flames:* a study of flame structure (hottest part, oxidizing flame, reducing flame).
3. *Apparatus:*
   a. *Completion Type:* problems involving the completion of apparatus used in the preparation of ammonia, sulfur dioxide, testing for carbon dioxide, etc.
   b. *Incorrectly Assembled Types:* problems in checking types met with frequently and including unsealed thistle tubes, submerged delivery tubes, burners when not necessary.
4. *Borax Beads:*
   a. Identification of beads containing typical salts.
   b. Beads prepared in reducing flame instead of oxidizing flame.
5. *Electromotive Series of Metals:* problems of metallic displacement and the nature of the ions in the resulting solutions.
6. *Distillation:* study of the process and applications.
7. *Conductivity:* identification of electrolytes and the polarity of the electrodes.
8. *Electrolysis:* water, sodium chloride solution, and potassium chloride solution.
9. *Principles of Gas Collection:* problems involving density, solubility, and chemical activity with water.

10. Drying Gases: problems involving the use of several drying agents with various gases.

11. Reduction and Oxidation Reactions.

12. Classification of Apparatus: adaptability of certain types of apparatus for the preparation and collection of a given substance.

Test Questions

1. A student working in the laboratory read the following directions. "Filter the mixture and add ammonium hydroxide to the filtrate." The drawing in Figure 1 shows the filtering process. Indicate the filtrate by writing the word, "Filtrate," on the proper dotted line extending from the drawing.

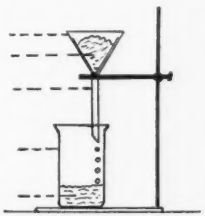


FIGURE 1

4. The drawing in Figure 3 represents a part of the apparatus required for the laboratory preparation and collection of ammonia gas. The apparatus, which contains the proper materials, as you will notice, does not contain a delivery tube. You will complete the apparatus by drawing a delivery tube in Figure 3, extending from the point *X* to the proper bottle for the collection of the ammonia gas.

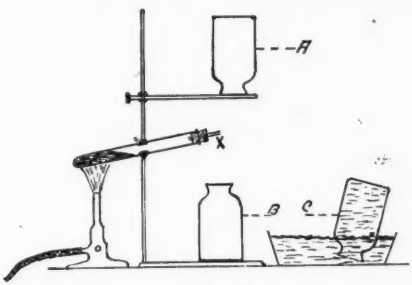


FIGURE 3

7. The properties of ammonia which make its collection necessary as indicated in the drawing in Figure 3 are:

a.....

b.....

44. It is not unusual to encounter certain difficulties in laboratory work. A student was trying to prepare hydrogen as shown in Figure 12, but after working for some time was unable to collect any hydrogen though a vigorous reaction seemed to be taking place in the generator, What was wrong? Study the problem carefully. Gas was not collected in bottle *B* because.....

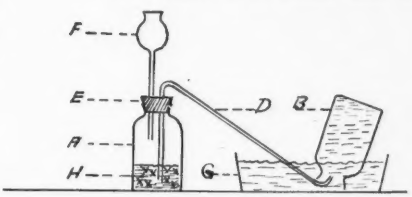


FIGURE 12

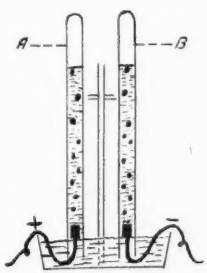


FIGURE 17

63. The illustration in Figure 17 shows apparatus which may be used in the electrolysis of a solution of sodium chloride. In "Tube *A*,".....will collect, while.....will collect in "Tube *B*."

64. The electrolysis of brine, as shown in Figure 17, is continued until the sodium chloride is entirely decomposed. The solution remaining in dish *C* will then contain.....

65. The apparatus in Figure 17 may be used for electrolysis of water by acidifying the water with sulfuric acid. The gas collecting in "Tube *A*" will be.....and that collecting in "Tube *B*" will be.....

Coöperating Schools

The tests have been given to several thousand students. From this testing program, data are available for 1726 students. More than twenty-three schools have coöperated in giving the tests although, at present, the results are available for only twenty-three.[1] The results represent the work of a considerably larger number of teachers since, in quite a few instances, several teachers are represented in the report of a given school. The schools represent a good geographical distribution and should represent a fair sampling of students.

Results

A brief statistical summary of the results are given in the table. These data are not offered in support of any conclusions to be suggested later. They are interesting however in showing the similarity of the two experimental forms of this test. The values given have been calculated from the total results of the testing program with the exception of the correlation coefficient which is based upon the scores of two schools. The two schools selected for calculation of the correlation coefficient are average schools located in different states, one being a county high

TABLE I

SHOWING MEANS AND STANDARD DEVIATION

	1927	1928 Form *A*	1928 Form *B*
Number of students tested	497	648	547
Mean, arith.	51.35 ± 0.293	46.6 ± 1.2	42.7 ± 1.4
Standard deviation	9.7 ± 0.21	10.10 ± 0.28	11.0 ± 0.33

[1] DELAWARE:
Wilmington, Tower Hill High
MASSACHUSETTS:
Boston, English High
Melford, Melford High
MICHIGAN:
Ann Arbor, Senior High
NEBRASKA:
Omaha, Technical High
NEW JERSEY:
Atlantic City, Public High
Morristown, Morristown High
OHIO:
Akron, West High
Barberton, Central High
Canton, McKinley High
Cleveland, East High
Cleveland, Glenville High
Cleveland, West High
Cleveland, Western Reserve Univ. (Summer)
Cleveland Heights, Heights High
Lorain, Lorain High
Salem, Salem High
Wadsworth, Wadsworth High
Warren, Harding High
Youngstown, South High
WASHINGTON:
Tacoma, Stadium High
WEST VIRGINIA:
Wayne, Wayne County High
Wheeling, Wheeling High

school and the other a small city high school. The reason for selection of these two schools is that the reports were more complete than the others.

TABLE II

COEFFICIENT OF RELIABILITY BETWEEN TESTS *A* AND *B*

City *A*	34 cases	0.881
City *B*	73 cases	0.887

The reliability coefficient was determined by means of the formula:

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$$

This is the calculation of the coefficient of reliability in terms of the deviations from the means.

The results obtained in making these tests furnish interesting data, as they suggest some rather definite tendencies of students in the interpretation of problems involving the use of laboratory apparatus. Conclusions established on the basis of the data now available may be considered premature. The data can be used to better advantage in continuing the investigation of the measurement of results of laboratory practice.

There are several reasons why the results can be considered as of only tentative value. In the first place, the tests are new, involving a kind of work with which the student was not familiar. From this angle, it may have taken him somewhat by surprise. Then, too, the data may indicate the difficulty of the test item as well as showing the achievement of the student. The first factor, the new type of test, makes it more difficult to interpret the results. Some work has been done in checking the achievement of students in laboratory work in high-school chemistry, but this work has been largely from a somewhat different approach.[2]

It may be assumed that any results obtained in making a study of this kind will serve best in stimulating further research as curriculum reconstruction proceeds. The results of laboratory practice in chemistry should yield to accurate objective measurement. Such measurement will have to be made before a final definition of the laboratory phase can be made in our new curriculum.

A brief summary of the results of testing more than 1700 students is presented here in order that one may more easily study the situation.

[2] Webb, H. A., "A Test of Laboratory Resourcefulness," *Sch. Sci. & Math.*, **27**, 457–65 (1927). Smith, H. A., "Achievement of Pupils in Laboratory Instruction," THIS JOURNAL, **3**, 307–13 (Mch., 1926). Horton, R. E., "Improvement of Scientific Ability through the Use of the Individual Laboratory Exercise in Chemistry," *Ibid.*, **6**, 1130 (June, 1929). Horton, R. E., "Measurable Outcomes of Individual Laboratory Work in High-School Chemistry," *Contribution to Education 303*, Teachers' College, Columbia University, New York City.

The analysis is submitted in the form of a summary of facts rather than by reference to the various questions since the entire test is not reproduced. These results show the total number of students tested, the number of correct answers, and the percentage of correct answers on the following facts tested.

Facts tested	Number tested	Correct answers	%Correct answers
Recognition of "filtrate" in a filtering process	1174	972	82.8
Locate the "oxidizing flame" of a Bunsen burner	1174	618	55.5
Locate the "reducing flame" of a Bunsen burner	552	216	39.2
Complete apparatus for preparation of NH_3. Draw a delivery tube from generator to bottle	1174	685	57.5
Know the properties of ammonia which determine the method of collecting the gas	1174	757	64.2
Complete apparatus for making a chemical test for carbon dioxide	1187	495	42.6
Know that hydrogen chloride gas cannot be collected by water displacement	1087	689	63.9
Know that zinc displaces silver ions from solution	552	256	46.4
Know that gas escapes through an unsealed thistle tube	1626	1100	60.3
Observe that delivery tube is below surface of liquid in the generator	552	321	58.2
Know that in electrolysis of brine, (NaCl):			
a. Chlorine collects at + electrode	1174	568	48.4
b. Hydrogen collects at − electrode	1174	204	17.5
c. Sodium hydroxide is formed	1174	360	31.1
Know that in the electrolysis of a solution of potassium chloride:			
a. Chlorine collects at + electrode	522	128	23.1
b. Hydrogen collects at − electrode	522	227	41.2
c. Potassium hydroxide is formed	522	139	25.2
Know that in electrolysis of water:			
a. Oxygen is liberated at + electrode	1174	421	35.8
b. Hydrogen is liberated at − electrode	1174	533	45.3
Complete apparatus. The conditions of reaction and the properties of the product are given	522	210	38.1
Observe incorrectly set up apparatus:			
a. Use of Bunsen burner in the preparation of hydrogen	1174	572	48.7
b. Short thistle tube, gas escapes	1174	721	61.4
c. Short thistle tube and long delivery tube reaching liquid in generator	1174	350	63.4

The data just presented in this study does not yield itself readily to comparative consideration, but must be considered on its own merits. One or two comparisons may be made with data obtained by Powers[3] in making the survey of student achievement in the subject matter of high-school chemistry. Powers found that 85.9% of the students tested understood

[3] Powers, Samuel R., "A Diagnostic Study of the Subject Matter of High-School Chemistry," *Teachers College Contribution to Education*, No. 149.

electrolysis of water. In the present investigation with a labeled drawing provided, 35.3% indicated that oxygen was collected at the positive electrode, while 45.3% knew that hydrogen was collected at the negative electrode. The results in the electrolysis of a solution of sodium chloride practically check with those obtained by Powers. There are not many points for making comparisons with other tests which are essentially based on the text material.

A summary of the results obtained in this investigation does not warrant definite conclusions. It is true that a study of the test results indicates some interesting tendencies, and encourages one to believe that it may be possible to measure with some degree of accuracy the laboratory technic as a product of the laboratory practice. The extent to which such objective measurement will be possible will require further investigation. It may be suggested that in continuing the work of this study, attention should be directed in determining the practice effect developed by giving occasional tests of this nature following closely upon the completion of the laboratory assignment. Such investigation will assist in arriving at more definite conclusions.

Chromium-Plated Laboratory Weights. The hardness of chromium plating is a considerable advantage in the case of weights that are much used, but this advantage is somewhat offset by the susceptibility of such a coating to attack by fumes of hydrochloric acid. The United States Bureau of Standards has tried this plating on three sets of weights which have been put into use in the chemistry division. In preparing these sets it was found that great care is needed in washing the plating liquid out from under the knob. If this is not done the weights vary with the changes in atmospheric humidity, as is the case with gold-plated weights. Some indication of the degree of care needed was given by the fact that one of the three sets was at first too variable to warrant regular certification, although a careful laboratory assistant, familiar with electroplating work, thought that he had washed this set thoroughly, and just as carefully as the other two sets. As in the case of gold-plated sets, it was found that this chromium plated set could readily be made constant by proper boiling and rinsing.—*Chem. Age*, **20,** 447 (May 11, 1929).

Scottish Smokeless Fuel Innovation. Smokeless fuel—guaranteed, like the gas supply, to produce a fixed maximum of heat units per ton, and to contain a minimum of ash content—will be placed on the market early this summer, when the world's biggest low-temperature coal distillation plant, being erected for the Bussey Co. at Glenboig, near Glasgow, is in operation. This innovation has been made possible as a result of special research on Scottish coals carried out by Dr. H. B. Cronshaw, the company's consulting chemist, in London. The new plant will produce over 400 tons of fuel daily. "Buying coal has been more or less a gamble to the public up to now," states Dr. H. B. Cronshaw in an interview. "With few exceptions one can never guess what the next ton—or bag for that matter—will be like. It may burn brightly, give intense heat, and leave little ash; on the other hand, it may be everything that coal should not be. Our new scheme will obviate this entirely. The housewife will know exactly what she is buying."—*Chem. Age*, **20,** 446 (May 11, 1929).

CHEMICAL EDUCATION IN SIXTY-NINE STATE TEACHERS' COLLEGES AND NORMAL SCHOOLS

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The teaching of chemistry in state teachers' colleges and normal schools is now very widespread. In order to ascertain the present status of the subject, a survey was begun by a study of the catalogs of sixty-nine state teachers' colleges and normal schools, which are distinct institutions, apart from school and college departments of education connected with universities. The evidence gained in this manner was supplemented with data obtained from the "Biennial Survey of Education," *U. S. Bureau of Education Bulletin* No. 23 (1926); *Proceedings of the N. E. A.* for the year 1927; and the reports of the Committees of the American Association of Teachers' Colleges for the years 1927 and 1928.

Catalogs of state teachers' colleges and normal schools for the years 1927–28 and 1928–29 were studied. These institutions are distributed among forty-three states, as shown in the accompanying table. Five states, namely, Delaware, Florida, Nevada, Utah, and Wyoming, do not have any institutions of the classes considered in this article.

Ten institutions in the list offer no courses in chemistry. Twenty-nine of the sixty-nine have the rating of Class *A* on the accredited list of the American Association of Teachers' Colleges for February, 1928. Forty-three institutions comply with the standards for the "Preparation of the Faculty," as designated by the above association, as follows:

"The minimum scholastic requirement for members of the faculty who give instruction in the college department shall be graduation from a college of recognized standing and additional training, which shall include at least one year of study in their respective fields of teaching in a recognized graduate school, or equivalent, and presumably possession of the master's degree." All of the instructors in chemistry at these colleges and normals (see "Instructors and Their Degrees" in accompanying table) have at least the bachelor's degree; 54% have the master's degree; 14% have the Ph.D. Comparing this record with that in other fields, a check was made of all members of the faculties, and it was found that approximately two hundred and seventy instructors had no college degree. These members represented the following fields: art, education, home economics, industrial education, physical education, and social science.

A study of the chemistry courses offered by each of the sixty-nine state teachers' colleges and normal schools reveals the following facts: twenty-six institutions list in their catalogs an average of 9.4 courses in chemistry each semester; thirty-three institutions average 12 courses each quarter; and ten offer no chemistry courses whatever. The study also shows that there is a great variety of chemistry courses. They may be ranked ac-

cording to the number of times listed in all of the catalogs: first, general chemistry; second, organic chemistry; third, quantitative analysis; and fourth, qualitative analysis. Other courses which are very common include household chemistry, food chemistry, agricultural chemistry, physiological chemistry, and the teaching of chemistry. Only one institution of the sixty-nine offers a course in chemical research. It "deals with general methods of approaching problems in chemical research;" and is given by the Western State College of Colorado.

There is an unnecessary, wasteful, and confusing lack of uniformity in the prerequisite for general chemistry. Fifty-seven institutions offer a course in general chemistry without requiring high-school chemistry as a prerequisite; and sixteen offer an additional course in general chemistry for those having credit in elementary chemistry. Five California institutions will accept students having credit in high-school physics and trigonometry in place of the high-school chemistry prerequisite, while one Virginia teachers' college offers a general chemistry course open to third- and fourth-year college students in addition to the elementary course for freshmen. Two institutions, one in California and one in West Virginia, offer no course in general chemistry having no prerequisites.

The chief aim of the general chemistry course was found to be, "to give a foundation in the fundamental principles of the science." Other aims were, "to give the high-school science teacher a background for living and teaching," also to "give principles and applications."

One teachers' college places especial "emphasis upon the scientific method of attacking problems. Extreme rigor is demanded of the student in his definition and use of scientific terms, and his reports of observations in the laboratory, and the conclusions to be drawn from them."

The work in chemistry at these institutions is organized under three different heads: first, chemistry department; second, science department; third, physical science (see "Organization of Work" in accompanying table). Twenty-two colleges have a separate chemistry department; while in fourteen the work is combined with physics; and in twenty-three it is part of the science department. Under the latter two systems the chemistry instructors are required to teach other subjects in addition to chemistry, in many cases.

It is interesting to note that the work in chemistry is organized as a separate department in seventeen of the twenty-nine Class *A* teachers' colleges and normal schools listed in the table. By comparing the data for these seventeen in columns 2 and 3 of the table it is found that they average seventeen courses in chemistry each quarter, while the other twelve average eleven courses each quarter. The student enrolment has no influence upon the three systems of organization, because each type may

be found in very large institutions. There is a lack of uniformity in this matter among the colleges of the same state.

Conclusions: 1. The preparation of instructors of chemistry for their work is better than that of teachers in other fields of instruction at the sixty-nine teachers' colleges and normal schools studied in this survey. This is remarkable in view of the fact that, according to Dean W. S. Gray of the School of Education, University of Chicago, "teacher-training institutions of collegiate rank are of relatively recent origin."*

2. It is evident that in many of these teacher-training institutions, the study of chemical facts is overdone, since the essence of science is the scientific method. The scientific method involves careful experiment, accurate observation, and cautious inference. The influence of the "one and two year" curriculums upon the types of college chemistry courses is still very powerful, as shown by titles and aims.

3. The majority of the Class *A* teachers' colleges have a chemistry department which is separate and distinct from the other fields of science. This class offers more courses in chemistry and appears to be the leader in the preparation of science teachers.

4. Certain facts, showing deficiencies and standards, have been pointed out in this discussion. Detailed knowledge of what is needed and the spirit of professional zeal for making teaching comparable to the other professions, should tend to make chemistry teachers realize adequate standards for chemical education in teachers' colleges.

* *N. E. A. Proceedings*, **1927.**

Tuberculin Test for Tuberculosis. For the first time the substance used to determine the presence of tuberculosis in human beings and in cattle has been prepared in an absolutely pure state. The method of preparation of this substance, which is called tuberculin, was described recently to members of the National Tuberculosis association by Drs. Esmond R. Long and Florence B. Seibert of the University of Chicago, who have developed this pure tuberculin.

The accuracy of the tuberculin test in the past has been questioned but this new very pure tuberculin is free from foreign substances which formerly interfered with the test and made the results doubtful. Diagnosis of tuberculosis will therefore become much more exact. This will make it possible to detect the presence of the disease in children suspected of infection much earlier than formerly, with the result that treatment can be started much earlier.

The newly purified tuberculin will also have an important commercial effect in the possible saving of many cows. These animals are slaughtered when they react positively to the tuberculin test. In the past, impurities may have caused the positive reaction but no chances of children drinking infected milk could be taken and the cows had to be killed. Now the doubtful cases, in which cows show no signs of the disease, will be eliminated, as the new tuberculin, free from impurities, will only give a positive reaction with those animals that are definitely infected, authorities here stated.—*Science Service*

SELECTING A CHEMISTRY TEXTBOOK

C. H. NETTELS, LOS ANGELES CITY SCHOOLS, LOS ANGELES, CALIFORNIA

One of the very practical problems of the curriculum worker is that involved in the selection of adequate textual material to be used with the course he is developing. While it is undoubtedly true that the curriculum itself is of major importance, it is nevertheless a very pertinent fact that there must be material which the teachers must have to teach the subject. If the curriculum is not closely paralleled by textual material, many teachers will find it impossible to follow the course of study as outlined. This is not so much a lack of the desire to do the task well, as it is a lack of inability to organize and teach materials which are not well taken care of by textbooks. And it is well to remember at all times that curriculums are made for the average teacher as well as for the expert one. Educational theorists are perhaps prone to produce courses of study without due regard to whether or not there is organized material for the courses. But in teaching, as in politics, "it is a condition that confronts us, and not a theory;" hence, it is well to bear in mind possibilities, and probabilities, as well as theories in constructing our courses of study and in our other curriculum work.

All progressive chemistry teachers are, of course, familiar with the monumental work of organizing adequately the high-school chemistry course which has been carried on over a period of years by the Committee of Chemical Education. The minimum course, together with adequate provision for the supplementary topics, will unquestionably be the basis for most progressive chemistry courses of study. One could undoubtedly find several texts which will certainly include the materials covered in this committee's report. What publishing concern would be foolish enough to print a manuscript which did not take adequate cognizance of work of national scope performed by a committee in any subject! As a matter of fact there are over a half-dozen chemistries at least which would be very satisfactory from the standpoint of the committee's report. But there are other factors to be considered. In the first place, there is no book which is written with minimum essentials only. In the selection of materials to be included in a book in addition to these minima there is, of course, a wide divergence of opinion and of practice. What does this author have to say about the structure of matter? Does that author have an interesting style of presentation of the material? Does this author adhere to the psychological presentation of new ideas; does he provide for adequate reviews; does he present new words enough times so that they may be mastered in a short compass? Does that author have anything to say about the men who have made the science of chemistry great through their efforts? Are modern advancements in this important study adequately taken care of

in this textbook? Are the illustrations in this text well made and do they aid in the teaching of chemistry? These and a multitude of other questions are raised when the study of chemistry textbooks is to be undertaken.

How should the textbook be selected; who should do it and by what process? In a small school system where there are few teachers of a subject the matter is relatively simple. In a large school system the matter is much more involved. Should the teachers have the right to select the book which they are to use? A champion of democracy would say yes. A champion of expediency would say yes. In fact, on almost any reasonable grounds one would say the same thing. Can a hundred teachers select a textbook? Should a small committee be appointed to study the available texts and report back to the whole group? To decide some of these questions, one of the larger school systems has designated one of its special divisions to act with any subject committees which contemplate the selection of new texts, and one member of this division acts as an important member of the steering committee. It is felt that one outside of those teaching the subject, one not interested in any one school or subject, but who has a good view of the whole school situation can be very influential in administering a program of textbook selection judiciously and impartially.

As basic to the question of the selection of texts in certain subjects, at least, the following general principles have been set up:

(1) All teachers, heads of departments, and administrators should know what factors are being considered in the evaluation and what weight is allowed to each.

(2) The factors should be selected with reference to the aims of the course for which texts are being evaluated.

(3) Objectivity should be the watchword in so far as possible in selecting the factors to be considered in the evaluation.

(4) As many of the users of the text as possible should be engaged very definitely in the work of evaluation.

With these principles in mind, the work may be started. The first step is to have the general committee, composed of a teacher from every high school in which the subject is offered, agree to the principles just enumerated. Following this, a committee known as the *criteria committee*, perhaps, is appointed to consider the various points to be evaluated.

The following steps should then be taken:

(1) The committee should study the objectives of the subject and the possibilities of evaluation by objective methods.

(2) The committee should read the studies which have been made on the subject and its related materials.

(3) The committee should set up the criteria upon which the merits of the texts will be judged.

(4) The criteria committee's report should be presented to the general committee for adoption. The report should include weights to be allotted to the several items. The report may, of course, be amended or changed by the general committee.

(5) Necessary committees should be appointed to study the texts in the light of the accepted report of the criteria committee.

(6) Each committee should examine one phase of the work.

(7) Each of these committees should submit a report which should be assembled and mimeographed in the central office. The completed report should be mailed to the teachers.

(8) The teachers vote on the various texts on the basis of each committee report.

(9) These reports are sent to the central office for tabulation and final presentation to the general committee.

(10) On the basis of the final returns, the general committee recommends to the principals a book for adoption for the coming four-year period.

There are several valuable outcomes to a work of this kind. In the first place, each teacher knows exactly what factors are being considered. The subjective method gives way in so far as is possible and desirable to objective methods. A great many teachers have made a contribution toward something in which they are vitally interested. The field of textual material in the subject under consideration is thoroughly investigated.

The actual outline of the criteria committee is herewith presented.

CRITERIA FOR THE SELECTION OF A CHEMISTRY TEXT

I. Subject Matter ..... 35 points
II. Method of Presentation ..... 35 points
III. Other Features ..... 30 points

I. SUBJECT MATTER

A. Introduction ..... (5 points)

1. Brief historical outline
2. The field of chemistry
3. Why study chemistry?
4. Manner of presentation of the above
   a. Calculated to arouse interest
   b. Arguments convincing

B. Inorganic chemistry ..... (20 points)

1. Topics in American Chemical Society Report, minimum and supplementary
2. Special theory
   a. Equilibrium and mass action
   b. Modern view of period arrangement including atomic numbers
   c. Principles of separation
   d. Factors causing changes in speed of reaction
   e. Oxidation and reduction
3. Recent developments
   a. Treated in understandable manner
   b. Inclusion of certain topics, such as
      1. Neon light
      2. Ethylene glycol
      3. Stainless steel.
4. Chemistry of everyday life, including such topics as
   a. Baking powders, soaps, etc.

C. Organic chemistry ..... (10 points)

1. Methane series, including petroleum industry
2. Other hydrocarbons
3. Halides
4. Alcohols, ethers, glycerine
5. Aldehydes, ketones
6. Acids, esters
7. Carbohydrates
8. Foods in general—carbohydrates, fats, proteins, minerals, and vitamins
9. Clothing
10. Dyes

II. METHOD OF PRESENTATION

A. Topics to be included in first part of the book ..... (20 points)

1. Valence and formulas introduced as early as possible
2. Ionization as soon as possible after water
3. Some logical arrangement
4. The fundamentals, chemical change, law of definite proportions, structure of matter, atoms, before ionization; in early part of the book
5. Equations adequately presented in early part of text
6. Oxidation and reduction (not merely addition of oxygen) in first semester
7. Gas laws not before end of first part of book
8. The greater part of chemical theory

B. Other points ..... (15 points)

1. Clearness of statement, especially definitions
2. Difficulty of sentences and of book in general
3. Are new concepts treated adequately?
4. Are certain psychological principles adhered to?
   a. Simple to complex
   b. Known to unknown
   c. Concrete to abstract
   d. One difficulty at a time
5. Methods and teacher helps included
6. Unusual features of the book

III. OTHER FEATURES

A. Laboratory manual ..... (17 points)

1. Experiments fit book and vice versa
2. Experiments should be provided for each chapter, if possible
3. Experiments not too long nor involved
4. Apparatus not too intricate
5. Common chemicals, easily obtainable, only materials used
6. Not too many diverting questions

B. Illustrations ..... (5 points)

1. Sufficient, not sufficient, too profuse
2. Quality of the subject of the illustrations
   a. Do they aid in the teaching of chemistry
3. Clearness

C. Mechanical features ..... (8 points)

1. Type
   a. Clearness
   b. Size
   c. Use of varied type faces; topic headings
2. Margins and spacing
3. Quality of paper
4. Binding
5. Clearness of cuts
6. Appendix
7. Index
8. Bibliography

A CONSTANT LEVEL WATER-BATH

NORVAL F. WILSON AND R. K. CARLETON, SHURTLEFF COLLEGE, ALTON, ILLINOIS

In many college laboratories where live steam is not available for evaporation purposes, it is difficult to maintain a water-bath at boiling temperature without its being watched more or less continuously. The accompanying diagrams outline a simple apparatus which nearly any student can set up and which, when properly adjusted, will eliminate personal attention almost entirely. At the time of writing the authors have had such a bath at boiling temperature heated continuously for 125 hours without any adjustment whatever.

The operation of the apparatus is briefly as follows (Figure 1). Water

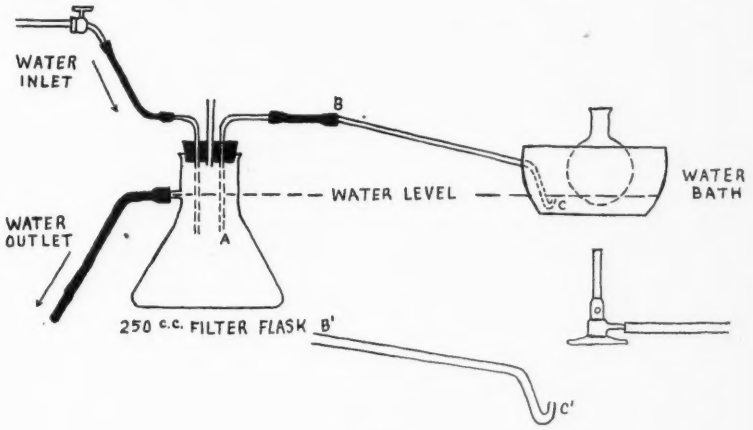


FIGURE 1

is siphoned from the filter flask through a siphon tube ABC into the water-bath until the water level in both becomes the same. When this point is reached the siphon temporarily stops flowing, but as the water level in the water-bath goes down, due to evaporation of the water, more water siphons over to equalize the two levels. The water in the filter flask is kept at the same level continuously by a constant but very small stream of water from the water tap. Excess water passes through the outlet into the sink. The central tube in the three-hole stopper in the filter flask is an air inlet that maintains the same atmospheric pressure in the filter flask as is at the other end of the siphon C in the water-bath. Closing this air vent creates back suction through ABC draining the water-bath. On the other hand, if the water outlet into the sink is temporarily closed, the water level in

the filter flask is raised and consequently the water level in the water-bath is raised.

The end of the siphon tube $B'C'$ is curved for the purpose of preventing steam bubbles from passing up the tube and stopping the siphon. Tube BC in actual operation, is kept cool by the flow of water into the water-bath. By raising or lowering the filter flask, the water level in the water-bath may be set at any height.

In practice it has been found that water from the water mains contains some dissolved gas which separates out when it reaches the part of tube BC

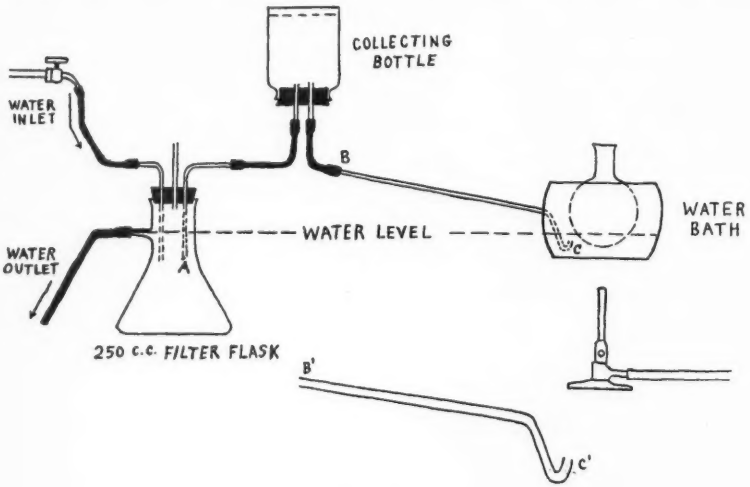


FIGURE 2

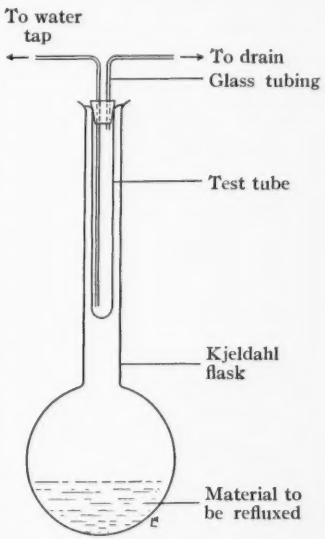
that is inside the water-bath, this part being very hot. These gas bubbles pass up through BC and collect throughout the length of the siphon tube, thereby preventing its operation. For periods of operation of four to six hours this is not objectionable, since the water outlet into the sink may be closed momentarily once or twice during that time and the bubbles will be ejected at C. To make the apparatus capable of operating for periods of several days and nights continuously, an inverted collecting bottle filled with water is inserted in the siphon line ABC, as shown in Figure 2.

I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt cheap at the money. It is a mere commonplace and everyday piece of knowledge that what these men did has produced untold millions of wealth in the narrowest economical sense of the word.—HUXLEY

A SIMPLE, EFFICIENT REFLUXING APPARATUS FOR QUANTITATIVE WORK

JEROME E. ANDES, MONTANA STATE COLLEGE, BOZEMAN, MONTANA

While some quantitative determinations of oils and fats were being made, it was found that the ordinary refluxing apparatus, which consists of a flask fitted to an upright condenser, was not suitable for refluxing volatile materials. Rubber stoppers could not be used to connect the condenser to the flask, as the volatile solvents used in connection with the fats tended to dissolve them. Cork stoppers were so porous that the volatile materials diffused through them. Also, the large area of surface on the condenser, even though carefully washed, seemed to cause an appreciable loss.



Accordingly, a refluxing apparatus was devised, as a result of a suggestion from Dr. B. L. Johnson of the Chemistry Department of Montana State College, which is similar in principle to the condenser used in ether-extraction work. It is very easy to construct. As the illustration shows, it consists mainly of a long-necked (Kjeldahl) flask fitted with a test tube of such a size that it will just slip inside the neck of the flask. The rim of the test tube prevents its dropping into the flask. The test tube is fitted with a two-hole rubber stopper, containing two pieces of bent glass tubing as shown. The piece of tubing extending to the bottom of the test tube is connected to the cold water tap, and the other to a drain. This keeps the tube full of cold water, the coldest water being at the bottom where the vapors of the boiled material first strike.

The material to be refluxed is introduced into the flask and the test tube placed in position. The cold water flowing through the test tube presents an excellent cooling surface. This condensing surface is of glass, which entirely eliminates errors due to solvent action. The space between the neck of the flask and the test tube is so small that it is almost impossible for any gases to escape uncondensed.

This apparatus was tried with a toluene solution of acetic anhydride. After an hour's refluxing, careful titrations failed to detect any loss of the volatile anhydride.

THE FIFTH CENSUS OF GRADUATE RESEARCH STUDENTS IN CHEMISTRY, 1928

CLARENCE J. WEST AND CALLIE HULL, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

The Census of Graduate Research Students in Chemistry, 1928, continues the annual compilation which was first issued in 1924.[1] It is interesting to note the steady growth in the number of students in American universities who are undertaking research in the various fields of chemistry: 1700 in 1924, 1763 in 1925, 1882 in 1926, 1934 in 1927, 2071 in 1928. Apparently no one field of chemistry has made any special stride in the number of men whom it interests, as all of them fluctuate from year to year. Practically the same number of universities report annually. One hundred and thirty-seven are represented in the 1928 compilation, though 19 of these have only reported members of the faculty engaged in chemical research.

This year the name of the Head of the Department of Chemistry (Table I) is again included; this list should prove a useful guide, and should also serve as an authority for the statistics.

TABLE II

NUMBER OF GRADUATE STUDENTS ENGAGED IN RESEARCH IN VARIOUS FIELDS OF CHEMISTRY

Subject	1928 Total	1928 M	1928 D	1928 F	1927 Total	1926 Total	1925 Total	1924 Total
General and Physical	406	183	223	218	430	343	332	240
Colloid	86	31	55	31	79	58	77	69
Catalysis	27	9	18	24	28	31	33	51
Subatomic and Radio	18	6	12	14	21	21	27	20
Electro-inorganic	25	12	13	17	21	32	42	38
Electro-organic	13	10	3	13	11	13	14	18
Photochemistry and Photography	22	5	17	17	25	25	19	24
Inorganic	124	55	69	62	116	109	86	101
Analytical	96	50	46	82	75	54	44	71
Metallurgical	22	16	6	18	21	34	28	38
Organic	668	300	368	222	570	475	430	422
Physiological	146	70	76	110	134	207	196	172
Pharmacological	11	2	9	19	7	14	20	30
Pharmaceutical	16	9	7	14	14	21	39	20
Sanitary	30	20	10	8	25	11	12	9
Nutrition	52	24	28	28	58	51	76	48
Food	52	29	23	24	27	37	49	35
Agricultural	111	42	59	76	89	72	55	91
Industrial and Engineering	156	97	59	92	183	274	184	203
Totals	2071	970	1101	1089	1934	1882	1763	1700

[1] Zanetti, *Ind. Eng. Chem.*, **16**, 402 (1924). Norris, *Ibid.*, **17**, 755 (1925). West and Hull, THIS JOURNAL, **4**, 909 (July, 1927); **5**, 882 (July, 1928).

TABLE I

NUMBER OF GRADUATE STUDENTS ENGAGED IN RESEARCH IN CHEMISTRY

"M" indicates those working for a Master's degree, "D," Doctor's degree, and "

Universities by State	General and Physical			Colloids			Catalysis			Subatomic and Radio			Electro Inorganic			Electro Organic			Photochemistry and Photography			Inorganic			Analytical			Metallurgical			Organic			Ph lo
	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M
Alabama:																																		
Howard College															1																	1		
Univ. of Alabama	2		1																									1		1	5		2	
Arizona:																																		
Univ. of Arizona	2		2																												1	1	3	
Arkansas:																																		
Univ. of Arkansas	1																					1			1		1						2	
California:																																		
Calif. Inst. Tech.	4	5	6								3	1			1				1	2	2						1				3	2	2	
Mills College	1		1																						1									
Pomona College			1																														1	
Stanford Univ.	9	5	5	1	8	3				1	1	1							1		1										4	5	4	5
Colorado:																																		
Colorado College																																	1	
Univ. of Colo.	1	2	1																	1				1			1				2	4	2	1
Connecticut:																																		
Conn. Agr. College																									1		2							
Trinity College	1		2																												1		1	
Wesleyan College							2		1																1		1				2		1	
Yale Univ.		11	6					1	2												1						1					23	8	
Delaware:																																		
Univ. of Delaware																																	1	
District of Columbia:																																		
Amer. Univ.			1																								1							
Catholic Univ.	1	1	1																							1	1					1	1	
Geo. Washington Univ.	1	1	2	1	1		1																1		2						5	3	1	5
Georgetown Univ.																									3						1	3		
Florida:																																		
Univ. of Florida																						1									1		1	
Georgia:																																		
Wesleyan College			1																								1							
Hawaii:																																		
Univ. of Hawaii																																	1	
Idaho:																																		
Univ. of Idaho			2																								3						1	
Illinois:																																		
Ill. Wesleyan			1																														1	
Monmouth College									1																									
Northwestern Univ.	2	1	3																												13	20	9	
Univ. of Chicago	5	4	1		7	1					2	1							4	2		4	5	2	2						11	41	6	5
Univ. of Illinois	3	10	4										1	1								3	3	7	2	14	5				22	36	5	5
Indiana:																																		
Indiana Univ.	3	6	2													2						4		1							2	3	2	
Purdue Univ.	1	2	2																			2	1	2	1		1				4	4	2	
Rose Polytech. Inst.			1																					1						1				
Univ. of Notre Dame	1		1																									1	2	1	9	3	1	1
Iowa:																																		
Grinnell College																															2		1	
Iowa State College	2	5	2	1	6	1																1	10	2							6	17	1	5
State Univ. Iowa	3	6	1	1	1	1		1				1	1									4	1	2	3	2	1	1	2	1	8	6	3	4

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TABLE I

IGAGED IN RESEARCH IN CHEMISTRY ACCORDING TO UNIVERSITY AND SUBJECT

er's degree, "D," Doctor's degree, and "F," number on faculty engaged in research

Analytical			Metallurgical			Organic			Physiological			Pharmacological			Pharmaceutical			Sanitary			Nutrition			Foods			Agricultural			Industrial and Engineering			Total			Head, Department of Chemistry
M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	
			1		1	5		1 2																						1 1			3 5			John R. Sampey Stewart J. Lloyd
						1	1	3																			4						3	1	9	Ernest Anderson
1	1							2			4							2		1	1												6		8	Harrison Hale
	1					3	2	2			1											1							1	1		8 2	13	14 2	A. A. Noyes V. L. Gibbons
						4	5	1 4	5	4	2																		1	1				3 17	C. J. Robinson R. E. Swain
	1					2	4	1 2	1		1							7	6						1					1 1		11	13	2 8	..... J. B. Ekeley
1	2					1		1																								1		2	Howard D. Newton
	1					2		1										1														2		3	V. K. Krieble
4	1						23	1 8																						4	1	6	39	3 19	G. Albert Hill .....
								1																						1				2	A. S. Eastman
	1	1																																2	W. B. Holton
1	1						1	1																								1	3	3	Hardee Chambliss
2						5	3	1	5	1	3																1						15	8	6	C. M. Mackall
2						1	3			1	3			2								2											4	4	7	G. S. Coyle
						1		1						1	2		2	1								1		1	2		1	8		6	Townes R. Leigh
	1										1																							3	Leon P. Smith
								1			1																	1						3	.....
	3							1																										6	C. L. von Ende
								1												1														2	F. S. Mortimer
																																		2	W. S. Haldeman
						13	20	9																10	7	2							15	21	12	Frank C. Whitmore
2						11	41	6	5	15	7	1	2	3																			38	87	25	Julius Stieglitz
14	5					22	36	5	5	4	3			1				3	3	2	1	1		2		1				8	4	8	49	76	37	Roger Adams
	1					2	3	2		1																	1		1				11	10	5	Robt. E. Lyons
						4	4	2																									9	7	8	R. B. Moore
		1	1	2	1																									1				4	John White
						9	3	1	1		1																						12	5	4	H. B. Froning
						2		1																											Leo P. Sherman
						6	17	1	5	5	1											2	1	5	4	1	4	18	4	5	7	3	29	74	16	W. F. Coover
2	1		1	2	1	8	6	3	4	4	5		1	2			3	3	1	2	2	1	1	7		7				7	2	1	44	28	31	Edward Bartow

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| | | |

Univ. of Dayton	1																					1				2					
Western Reserve	3		1	1		1	1	3	1										7	7	1					2		1	3		
Wittenberg College																												1			
Oklahoma:																															
Agr. and Mech. Coll.	2		1																							5		1	6		
Oregon:																															
Univ. of Oregon	1		2	2		1																				3		1			
Pennsylvania:																															
Bryn Mawr College			2																								1	1			
Bucknell Univ.																						1		1							
Dickinson College			1																												
Grove City College	2		1																			1		1							
Haverford College	2																					2									
Lafayette College	2		1																												
Lehigh Univ.	4		3	1					1																1	3		3	2		
Penn. State College	1	8	2	1					1											3	2			1			4	2	1		
Swarthmore College			1															1										2			
Univ. of Penn.							1		5*						2	1				2	3			4				5			
Univ. of Pittsburgh		4	2		1		1		1				1	1	1					2	1			3		3	7	1	4		
Pittsburgh Coll. Pharm.																					1										
Rhode Island:																															
Brown Univ.	2	5	3				1		1								1		2	2						1	6	2			
R. I. State College																															
South Dakota:																															
S. D. State College																						1								1	
S. D. State School Mines																															
Tennessee:																															
Univ. of Tenn.	1		2																							3		2			
Vanderbilt Univ.	1		1									1												1	1	2		1			
Texas:																															
A. and M. College																															
Baylor Univ.			1																									1			
Rice Inst.		2	2	2	1	1																					1	1			
Univ. of Texas	5		2																					1		6	1	3			
Utah:																															
Univ. of Utah	4		2																							2		1			
Utah Agr. College	1		1	1																	1										
Vermont:																															
Middlebury College										1		1														3		1			
Univ. of Vermont	2		2																									1			
Virginia:																															
Roanoke College	1		1																		1					4		3			
Univ. of Virginia	1	5	2					3	1										1	1	1	1		1				2			
Va. Polytech. Inst.						1													1						1						
Wash. and Lee																	1				1										
Wm. and Mary																															
Washington:																															
State College Wash.	1		1			1							1		1						1					3		2			
Univ. of Washington	7	1	2	3	2														1		1	5		1		3	1	2			
West Virginia:																															
W. Va. Univ.				2															2			1				4					
Wisconsin:																															
Marquette Med. School																								3							
Univ. of Wisconsin	7	10	8	1	3	2		2	2				1			1		1	1	4	1	3	3			16	10	4	2		
Wyoming:																															
Univ. of Wyoming			1																									1			
Totals	183	223	218	31	55	31	9	18	24	6	12	14	12	13	17	10	3	13	5	17	17	55	69	62	50	46	82	16	6	18	300	368	222	70	7

| | | |

| | | |

It should be mentioned that in Tables II and III, while a column is given to the faculty, the numbers given there are not included in the totals, as those numbers refer only to the graduate students, and are comparable with the totals for the previous years.

An effort has again been made to eliminate the counting of one person more than once. However, it is not always possible to detect such errors of listing, and the compilation is offered with the hope that, in the future, the heads of the chemical departments will see that this interpretation is strictly followed.

TABLE III

NUMBER OF GRADUATE STUDENTS DOING CHEMICAL RESEARCH, BY STATES

State	1928 Total	1928 M	1928 D	1928 F	1927 Total	1926 Total	1925 Total	1924 Total
Alabama	8	8	0	8	10	5	3	11
Arizona	4	3	1	9	4	3	6	3
Arkansas	6	6	0	8	2	2	0	2
California*	68	31	37	36	106	91	120	118
Colorado	24	11	13	10	23	25	26	26
Connecticut	48	9	39	27	32	57	60	55
Delaware	0	0	0	2	1	1	0	0
District of Columbia	35	20	15	18	36	17	15	10
Florida	8	8	0	6	10	7	5	4
Georgia	0	0	0	3	0	0	7	4
Hawaii	0	0	0	3	0	2	1	2
Idaho	0	0	0	6	2	0	0	2
Illinois	286	102	184	78	250	241	203	175
Indiana	54	32	22	21	48	18	20	26
Iowa	177	75	102	48	174	140	125	104
Kansas	32	23	9	25	49	22	23	3
Kentucky	7	7	0	5	2	6	13	12
Louisiana	25	25	0	17	30	20	20	18
Maine	3	3	0	7	2	2	5	10
Maryland	62	17	45	22	52	47	43	39
Massachusetts	108	44	64	82	101	197	180	189
Michigan	56	26	30	20	86	84	66	48
Minnesota	82	28	54	69	43	46	6	94
Mississippi	3	3	0	5	2	2	0	1
Missouri	66	42	24	48	60	57	37	52
Nebraska	31	24	7	14	27	25	21	21
Nevada	1	1	0	3	2	2	3	3
New Hampshire	2	2	0	1	1	1	0	3
New Jersey	52	20	32	44	50	30	18	24
New Mexico	0	0	0	4	0	0	1	0
New York	279	95	184	126	208	265	214	200
North Carolina	29	13	16	17	34	23	25	14
North Dakota	1	1	0	2	3	1	8	3
Ohio	116	57	59	48	131	123	118	85
Oklahoma	15	15	0	6	9	11	13	15
Oregon	6	6	0	4	6	5	9	8

TABLE III—*Concluded*

State	1928 Total	M	D	F	1927 Total	1926 Total	1925 Total	1924 Total
Pennsylvania	112	61	51	83	84	72	88	87
Rhode Island	21	8	13	10	20	21	18	6
South Carolina	0	0	0	0	0	1	0	5
South Dakota	2	2	0	1	7	3	16	7
Tennessee	9	9	0	10	6	10	7	7
Texas	30	23	7	19	33	30	30	25
Utah	6	8	0	8	11	7	3	9
Vermont	6	6	0	5	6	7	3	9
Virginia	18	10	8	23	14	18	14	16
Washington	32	26	6	19	20	27	24	31
West Virginia	11	11	0	0	3	6	8	3
Wisconsin	128	49	79	56	121	107	138	118
Wyoming	0	0	0	3	3	0	0	0
Totals	2071	970	1101	1089	1934	1882	1763	1700

* The drop in the total for California this year is due to the fact that the Department of Chemistry of the University of California has made a rule to answer no questionnaires of this kind.

The Medals of the Franklin Institute. The medal meeting of the Franklin Institute, Philadelphia, was held on the afternoon of May 15th at 3.30.

Presentations were made as follows:

Certificate of Merit to MR. GEORGE F. MACHLET, American Gas Furnace Company, Elizabeth, New Jersey.

Longstreth Medals to MR. EDWARD G. HERBERT, Atlas Works, Manchester, England; DR. KONRAD JAGSCHITZ, Mainz, Germany; MR. A. W. MACHLET, American Gas Furnace Company, Elizabeth, New Jersey; and MR. J. F. PETERS, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Wetherill Medals to MR. GUSTAVE FAST, The Bartlett Hayward Company, Baltimore, Maryland; MR. W. H. MASON, Masonite Corporation, Laurel, Mississippi; and DR. JOHANNES RUTHS, Djursholm, Sweden.

The Levy Medal to MR. LODEWYK J. R. HOLST, Brock and Weymouth, Inc., Philadelphia.

Cresson Medals to SIR JAMES C. IRVINE, St. Andrews, Scotland; DR. CHEVALIER JACKSON, Jefferson Medical College, Philadelphia; and DR. ELMER A. SPERRY, Sperry Development Company, Brooklyn, New York.

Franklin Medals and *Certificates of Honorary Membership* to MR. EMILE BERLINER, Washington, District of Columbia, and DR. CHARLES THOMSON REES WILSON, Cambridge, England, received by SIR ESME HOWARD, British Ambassador to the United States.

The following papers were read:

"Vocal Physics—Historical Notes," by EMILE BERLINER, and "Some Thundercloud Problems," by C. T. R. WILSON, University of Cambridge, who was represented by Professor JOHN ZELENY of Yale University.—*Science*, **59**, 466 (May 3, 1929).

THE MINNEAPOLIS MEETING

(Tear Out and Mail)

Mail to
R. A. BAKER, *Secretary*, Division of Chemical Education,
Syracuse University, Syracuse, N. Y.

I plan to attend the Minneapolis meeting of the American Chemical Society.

I do (not) wish to present a paper before the Division of Chemical Education.

Title.....

.....

Time required.....minutes

Lantern?.....

Moving Picture Projector?

I do (not) wish to receive information concerning rooming and camping facilities near the University of Minnesota.

.....
(Name)

.....
(Address)

Papers for Program.—Early notice from authors will enable the *Secretary* to plan the program more efficiently. Abstracts should be sent as soon as possible for the same reason. To appear on the Minneapolis program the completed paper as well as the abstract in duplicate must reach the *Secretary* not later than August 3rd. In general, not longer than 20 minutes will be available for each paper.

Dormitory and Camping Facilities.—President Coffman has authorized the use of Sanford Hall for girls and a number of the University cottages for boys and married couples, respectively. The rate for these rooms will be 50 cents per night per person.

The best facilities for camping are at the municipal camp grounds near Minnehaha Falls, where the rate for tenting parties is 50 cents a night, or for cabins $1.50 per day. Tents may be pitched at the University farm without charge.

Those wishing to avail themselves of the dormitory facilities should correspond at once with the Local Secretary of the Division of Chemical Education, Dr. H. H. Barber School of Chemistry, University of Minnesota.

Chemical Digest

COLLEGE TEACHING

We have become familiar with the cry of the college student against the teaching and standards they have met with in college. We have been among the criers ourselves. And now comes Mr. Laski[1] striking a danger note in the tendency of our industrial civilization in respect to higher education. After showing how universally it has been believed in the past that the "academic minds are too remote from reality to be helpful when the need comes for decisive acts" he says that:

> They (the professors) saw that they were poor; they felt that they had no part in the making of supreme decisions. Though they were professors, they were human and they determined to be practical men. The passionate intensity of their determination has exhibited itself in innumerable ways.

The examples he offers us are interesting and rather frightening. But perhaps even more disastrous than the molding of the academic mind to practical uses is the filtration of the practical business mind into places of high authority in university life.

> It would not, perhaps, be going beyond the mark to define the average academic mind of today as that of a practical man who has, at least in the major universities, exchanged wealth and power for dignity and security.
>
> Once practical men begin to meddle with universities mediocrity within is given its opportunity.

One main reason for this is that:

> . . . . . power searches always for routine, and when the academic politician becomes a university president there is nothing he so subconsciously fears as the genuinely inventive mind.

On the other hand:

> . . . . . the university that is free builds an atmosphere of creativeness for the great thinker who finds place there, and the generations that are to come move in response to the measure of his thought.

If the colleges are really in the danger that Mr. Laski declares them to be, we look to the faculty and executives to see what they are doing to save it. In connection with this, we turn to a study which Dr. Kelly,[2]

[1] Harold J. Laski, "The Academic Mind," *Harper's*, **1929,** 593–601 (Apr.).

[2] Robert L. Kelly, "Great Teachers and Methods of Developing Them," *Assoc. Am. Coll. Bull.*, **15,** 49–67 (Mar., 1929).

Executive Secretary of The Association of American Colleges, carried on by means of questionnaires in this country. Only denominational colleges participated.

> The first phase had to do with those individuals referred to on any college campus as "great teachers." . . . . . The second phase was concerned with the methods used by the college officers in the building of their faculties. . . . . A total of 187 colleges participated in the investigation of the great teachers, and a total of 162 in the study of the methods of building college faculties. Probably 200 colleges were concerned in both studies.

362 "great teachers" were named. 142 of these had the degrees of Ph.D., Sc.D., Pd.D., M.D., etc. 11 of these degrees were received at the University of Chicago, 10 at Columbia, 8 each at Cornell, Harvard, and Johns Hopkins. The qualities stressed most often were interest in students, scholarship, personality, and character. The subjects taught by the majority of these teachers were, in order, English, mathematics, philosophy, Greek, Latin, and history.

Some important conclusions have resulted from this report, which, though admittedly unscientific, is according to Dr. Kelly the best that could be done at the initiation of such a study.

> The decade in which the largest number of great teachers was listed was the decade ending in 1920.
>
> It appears that a considerable majority of these teachers have not been trained in education, but along with this finding must be considered the fact that a good majority of the college officials are now giving preferential treatment to those who have had training in education.
>
> These college executives do not believe that teachers have been listed as great because of their diffused interest in the problems of life in general. . . . . The overwhelming majority of them, while showing broad sympathies with life and with the institutions of life, have nevertheless held closely to the teaching of their subjects.
>
> The consensus of opinion is very conclusive that these teachers stimulated their students to further study in the graduate schools and elsewhere.
>
> In the matter of building faculties it appears that nearly all of these colleges profess to have some sort of technic. More of them rely upon the graduate school than upon any other agency of employment.
>
> There is a growing disposition to recognize that *teaching* counts and to promote teachers on the basis of good teaching as the major consideration.

Rees Edgar Tulloss,[3] the president of Wittenberg College, treats the problem as an executive sees it. He says: "In the last analysis, the quality of the teaching in our colleges depends upon the attitude of the administration," and then discusses the question from five viewpoints.

1. *Desiring Good Teachers.* The development of a dominating desire for better teaching is the first important step toward securing it.

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[3] "The Improvement of College Teaching as an Administrational Problem," *Assoc. Am. Coll. Bull.*, **15**, 73–89 (Mar., 1929).

2. *Detecting Good Teachers.* Certainly we should not make the mistake in thinking that the instructional methods required in college must be the same as those found useful in the elementary or secondary schools. . . . . It is quite possible that "what may be needed is a complete breaking away from tradition, and the devising of instructional methods suited to the demands of modern higher education." [M. E. Haggerty, *Assoc. Am. Coll. Bull.*, **14,** 391 (Nov., 1928.)]

Dr. Tulloss considers the problem of research here, and its effect, good and bad, upon the college professor. He concludes that there are few who can handle both research and teaching and do both well.

3. *Developing Good Teachers.* Our administrative help is sorely needed in developing a friendlier attitude toward the technical study of educational methods and in bringing about a willingness to believe that the department of education can really offer helpful coöperation.

He gives several important suggestions as means of developing teachers *as teachers*, and then says:

A danger in this whole procedure must not be overlooked—the danger that by emphasizing teaching technic, we encourage still further the pure utilitarian tendency of modern education, so that the ideal of "imparting knowledge rather than promoting human welfare" becomes still more general.

In connection with the Laski article in *Harper's*, we find some comfort here that the college authorities are awake to the invasion of the practical mind.

4. *Demanding Good Teachers.* (He discusses the problem of the degree of Ph.D.) If the Ph.D. degree is to be granted only in accord with the dictum of the American Association of University Professors there can be no question as to the need for a new degree. "The doctor's degree should be conferred only upon persons of unusual intellectual endowment, with unequivocal capacities for research." Why not a degree to be conferred upon persons of unusual intellectual endowment, possessing thorough acquaintance with a particular field and with *unquestionable capacity for effective and inspiring teaching?*

If it is true (he remarks further on) that at least 75 per cent of those persons who receive the Ph.D. become teachers, ... and if it is true, on the other hand, that not a single school in America (he excepts the Graduate School of Duke University) requires of those intending to teach, a course in the technic of college instruction as a prerequisite to the Ph.D.; and if it is true that 85 per cent of all the courses in that field are to be found within six of our universities—so anomalous a situation cries aloud for a changed procedure.

5. *Rewarding Good Teachers.* Why not reward what ought to be rewarded—skill in the doing of the real work of the teacher?

"Equal degrees, plus equal teaching experience, plus equal ranking, must mean equal salaries." How fallacious a theory. . . . . There is no sound reason why we should be hampered, within the limits of a flexible salary scale, in bestowing the reward of increased salary.

The regional accrediting associations must shoulder a large part of responsibility of the standards and ideals of the colleges and universities.

Floyd W. Reeves,[4] Director of Bureau of School Service, College of Education, University of Kentucky, has an interesting article concerning these associations. He summarizes his argument against their present position:

> Most of the standards of such associations are arbitrary in their nature; they measure the mechanics of education when there is no need for measurement of the product. During recent years much opposition has arisen to the methods of measurement employed. The regional standardizing associations are awake to the criticisms which are being made and are endeavoring to devise less mechanical methods for the selection of member institutions. As a means of developing more satisfactory standards the associations are encouraging experimentation and conducting studies to determine the validity of the present standards and the possibility of developing more satisfactory measures of the efficiency of educational institutions.

It is interesting to note that a committee of the North Central Association of Colleges and Secondary Schools:

> . . . . . recommended that the Association join the movement to encourage graduate schools to give more training in the methods and technic of college instruction to those students who expect to go into the field of college teaching.

We have noted the agitation concerning this matter in Dr. Tulloss' article, reviewed above. After all it is a great question whether or not training in technic is necessary for the really great teachers. We turn to President Guy E. Snavely's article, "Who Is a Great Teacher?"[5]

The most important thing here is the report of the Committee on Teaching Qualities, which committee was composed of members of Dr. Snavely's faculty, Birmingham-Southern College.

FACTORS IN TEACHING

1. *The individual factor*
   - (*a*) Integrity of character
   - (*b*) Culture
2. *The subject factor*
   - (*a*) Thorough knowledge of special subject and related subjects
   - (*b*) Knowledge of methods of teaching his subject, grading, outside reading, exams, lectures, etc.
   - (*c*) Enthusiasm
3. *The student factor*
   - (*a*) Sympathy in classroom
   - (*b*) Sympathy outside of classroom

Along with Dr. Snavely's definition of a great teacher—"The great teacher must have character, scholarship, and personality"—we should like to quote the definitions of great teachers given in the above-mentioned articles under this heading.

[4] "College Teaching—Uses and Abuses of Standardization," *Assoc. Am. Coll. Bull.*, **15**, 230–41 (May, 1929).

[5] *Assoc. Am. Coll. Bull.*, **15**, 68–72 (Mar., 1929).

Harold J. Laski: The great teacher will teach greatly; and do what we will, the consequence of great teaching is the sense in those taught that the actual social institutions are not coincident with the inevitable foundations of society.

Robert L. Kelly: The personal qualities or traits of the great teachers are, in order—interest in the students, knowledge or mastery of the subject, sympathy, helpfulness, character, and personality.

The best teacher is one who does not *teach*, if the concept is to be carried over from the lower schools, but the one who kindles the inner fires.

Dr. Tulloss finds himself inclined to agree with Oscar Wilde, who states in his book, "The Critic as Artist:"

Technic is really personality; that is why the artist cannot teach it, why the pupil cannot learn it, why the aesthetic critic cannot understand it.

He also quotes the rating for teachers given by the Oberlin scale:

1. Breadth and richness of his courses in respect to content
2. Organization of his courses
3. Clearness in explanation and in illustration
4. Getting the student's point of view
5. Skill in eliciting and directing discussion
6. Care in assignment of papers or other collateral work, and adequacy of consideration of the same
7. Accessibility for consultation
8. Interest in students as individuals
9. Stimulating the student to his highest level of achievement
10. General influence on student morale

Let us see what the professors have to say on the subject. Aretas W. Nolan,[6] Associate Professor of Agricultural Education, University of Illinois, has concerned himself with a study of the technic used by college teachers.

The purpose of this circular is to describe a study of technic and comments of a group of college instructors on certain problems of method in classroom instruction. Thirteen major problems were considered.

1. Learning to know students
2. Apportioning time to subject matter to be taught
3. Making daily preparation
4. Handling classroom discussion
5. Stimulating students to think
6. Securing interest
7. Testing and marking
8. Securing consistent work
9. Making the assignment
10. Stimulating students to use material learned
11. Memorization

[6] "Technics Used in Dealing with Certain Problems of College Teaching," *University of Illinois Bull.*, June 4, 1929.

12. Inspiring students to desire knowledge and power in the subject matter rather than mere credit and high marks
13. Training students in personal and social effectiveness

Eighty college instructors were presented with questionnaires on these problems. To illustrate how the work was carried on, we shall quote the third problem. The numbers in parentheses indicate the frequencies of the checkings or of suggestions on the technics, and the frequencies of the comments on the problems submitted.

PROBLEM III. MAKING DAILY PREPARATION

Technics

1. Go over the material in all texts, outlines, and notes on the subject matter unit to be presented, and organize it for the special class involved. (70)
2. Get lesson plan well in mind in order to be as free from texts or notes as possible. (32)
3. Think through the points to be used in the class period, without reference to outlines or books. (16)
4. Plan the method of presentation as carefully as the organization of subject matter. (10)
5. Use outlines of previous years, adding new material to bring it up to date. (6)

Comments

1. Best success in teaching comes from spending at least an hour each day in preparation for the class period. (14)
2. The class period is the testing time of the teacher's skill in his profession. (12)
3. Where there is no learning there is no teaching. (4)

Some important general conclusions from this study were:

The tendency of faculty members is to stress the importance of research over teaching.

A few of the instructors believe that if one knows his subject he does not need to be concerned with the problem of method in teaching.

Increased interest in this problem (*i. e.*, improving the quality of college teaching) is evident throughout the country. Some colleges require previous teaching experience as a condition of employment; others require a certain number of hours of professional education; and still others provide college courses, lectures, or forums in professional education for instructors in service.

Progress is being made in the study of methods in college teaching, but there is need for much improvement. This study of technic of methods used and the comments as given by faculty members on the thirteen problems listed should be of some value to college instructors, and should suggest an approach to further work along similar lines.

At the end of our reading, we find ourselves not much farther along the road than we were at the beginning. But a few things are apparent: either through outside criticism or through their own failure to achieve their goals, college authorities are beginning to demand good teaching

powers as an essential of the professor. On the other hand, while they are gradually recognizing values in educational technic, they do not believe that the accepted methods in elementary or secondary schools are basic for teaching in colleges. If we are depressed by Mr. Laski's article, let us turn for encouragement to this new movement. We have reason to believe that once the colleges are awake to their peril, they will send the *practical* mind scurrying back to its filing papers.

M. W. G.

German Synthesizes Ferment Which Rules Organic World. The respiration ferment, described as ruling the organic world, has been made artificially in the laboratory by Prof. Hans Fischer of Munich, who has thus made one of the most important contributions ever made in biochemistry. Prof. Fischer's achievement is far-reaching and may lead to isolation of the vitamins themselves.

Prof. Fischer's work confirms the research of Dr. Otto Warburg who last year demonstrated the nature and rôle of this important ferment. The respiration ferment is a hemin compound and its synthesis makes possible the artificial production of hemoglobin, the red coloring matter of the blood. In the higher animals, hemoglobin is a transport agency for oxygen, carrying it from one place in the body to another. But the respiration ferment is a substance which takes up the atmospheric oxygen, which was transported by the hemoglobin, and transfers it to certain organic substances which in turn become oxidized. The respiration ferment or enzyme rules the organic world, because in everything that happens in living matter, respiration furnishes the driving force. It is found in all living cells.

The synthesis of this compound is a good example of how optical instruments can aid in the solution of biochemical problems. Transmittency measurements, measurements of transmission or absorption of light, assisted in the solution of this problem.

Dr. Warburg, seeking a method to prove whether or not the respiration ferment was a hemin, measured the absorption spectra of a model pigment, hemonicotin, and determined its action curve. He then obtained the action curve of the respiration ferment, using yeast cells in which it is contained. Similarity between the action curve of the respiration ferment and of a true hemin compound showed that the ferment was a hemin compound also.

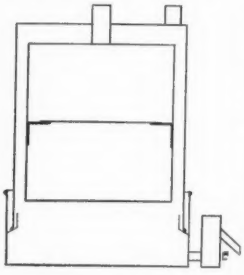
It is this compound that Prof. Fischer has just synthesized. This respiration ferment may become therapeutically important. It is a question whether it is more or less important than the four pyrrol nuclei with which Prof. Fischer started its synthesis. Hemin and chlorophyll, the green coloring matter of plants, both contain these four pyrrol nuclei. It is possible that the vitamins may be found in these very pyrrol nuclei. In that case, organic chemists even today have vitamins by the pound in their laboratories and do not even know it.—*Science Service*

No Vitamins in Honey. Honey is a popular and suitable food for the nursery but cannot be regarded as a satisfactory supply of vitamins. Tests carried out on a fresh sample of English honey from the comb and West Indian honey showed that both samples were deficient in vitamins A, B, C, and D. This work was carried out by Dr. Edward Hoyle at the Lister Institute, London. Dr. Hoyle also found that the deficiency of vitamins in honey is not due to deterioration caused by storage.—*Science Service*

ABSTRACTS

TEACHING METHODS, AIDS, APPARATUS, AND SUGGESTIONS

A Steam Drying Oven with Detachable Base. H. J. S. SAND. *J. Chem. Soc.*, **1929,** 214.—"The base of this oven is constructed as a separate unit distinct from the rest, the junction between the two parts being made by a hydraulic seal (see Figure). This is effected by fitting the top of the base with a gutter, which is maintained full of water by condensation from the walls of the oven, the excess overflowing into the base. The general construction will be apparent from the section shown. The device is useful for small laboratory steam-ovens, since the base can be readily freed from scale, and renewed if necessary. It is, however, particularly valuable for larger combined ovens and stills. For these, the top of the oven is fixed rigidly to a stand, the base being supported on two cranked rods, to which handles are attached, by the turning of which the base may be instantly lowered and removed for cleaning. In ovens which are fitted with a reflux condenser and water gage and are charged with distilled water, all loss of water by evaporation should be prevented; this may be effected by floating a small amount of paraffin wax on the outer portion of the water forming the seal." M. W. G.



An Improvised Iron Mortar and Pestle. G. W. CORRIE. *Chem. Analyst,* **18,** 16 (Mar. 1, 1929).—"The following suggestions may prove of some use to the chemist who is confronted with the problem of crushing coarse silicate rock. It frequently happens that a small jaw crusher or rolling mill is not available and there is a natural reluctance to chipping and nicking a good laboratory mortar and pestle.

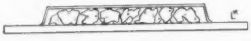


FIGURE 1

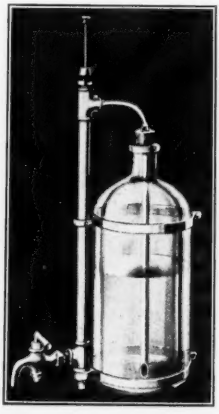
"Beryl, which is primarily aluminum silicate, was the material under examination and was received in pieces about the size of apples or baseballs; these pieces were reduced to the size of peas by placing in a burlap bag and crushing with a hammer.

FIGURE 2

"The pieces were then further reduced in size by placing them on a piece of sheet steel, covering with the inverted cover of a friction top can (Figure 1) and using a hammer as the pestle, pounding the top of the cover.

"This results in a pulverization of the material to about 20 mesh. It can then be reduced to 60 mesh by again inverting the cover (Figure 2) and pounding with a hammer.

"As an emergency iron mortar and pestle this method has given very efficient satisfaction and may prove of service to others in pulverizing similar material." M. W. G.



New Siphon Pump. *Instruments,* **2,** 109 (March, 1929).—"The illustration shows a one-gallon bottle equipped with this new siphon pump. The pump can also be supplied to fit any size bottle, carboys, or even barrels.

"This siphon pump is made both of Monel nickel polished outside and of brass, tinned inside and finished nickel on the outside. It eliminates entirely the inconvenience as well as the personal danger often involved in the use of the ordinary type.

"For use on bottles it consists of two supporting rings, siphon pump, and draft cock." M. W. G.

A New Automatic Pipet. L. N. MARKWOOD. *Ind. Eng. Chem., Anal. Ed.,* **1,** 82 (April 15, 1929).—"A pipet to deliver an exact quantity of carbon tetrachloride from a vessel immersed in a constant-temperature bath was vainly sought by the writer. The usual form of pipet is not satisfactory for accurate work on account of the error introduced by the cooling effect while the liquid is being drawn into the bulb and during the time needed for adjust-

ment to the line. Any instrument having a stop-cock is also unsuitable on account of contamination from the lubricant. The instrument described here has neither of these disadvantages and was ideally suited to the purpose in hand.

"It consists of two parts—(1) the bulb with overflow arrangement, and (2) the valve rod which is ground in at the exit orifice to make a liquid-tight seal. In operation, the bulb is lowered into the liquid, the rod being out, until the level *a* is reached or exceeded, and the rod is dropped in place. As the pipet is raised out of the liquid, the surplus discharges through the overflow tube, *b*. The capacity of the instrument is the volume contained between the points *a* and *c*, minus the volume of the rod between those points. To deliver the contents the rod is simply lifted.

"An instrument of this type was tested for constancy of delivery with the results shown in Table I.

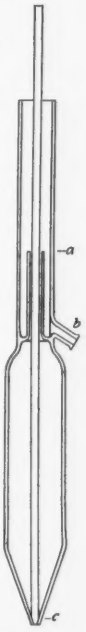


TABLE I—WEIGHT OF LIQUID DELIVERED AT 30°C.

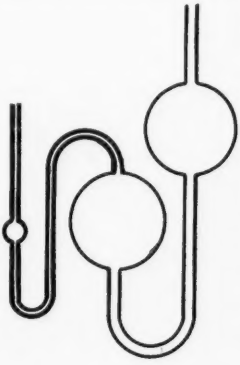
Carbon tetrachloride *Grams*	Water *Grams*		Carbon tetrachloride *Grams*	Water *Grams*
76.50	48.49		76.52	..
76.53	48.46		76.52	..
76.52	48.49	Average	76.52	48.47
76.52	48.47	Deviation	± 0.02	± 0.02
76.51	48.46			

These data show the delivery is quite constant.

"The obvious advantage of this instrument is that it automatically takes up and delivers a definite volume of liquid with a high degree of accuracy. The personal factor is entirely eliminated as there is no adjustment to a fixed line, and this fact is especially appreciated in routine work where a given volume is repeatedly required. In addition, the sanitary aspect is important, as it is undesirable to draw up many types of liquids by mouth.

"The writer believes this instrument may have application in other fields and welcomes suggestions for its further use. Patent protection has been applied for." M. W. G.

Modification of Hempel Gas Pipet. GEO. H. W. LUCAS. *Ind. Eng. Chem., Anal. Ed.*, **1**, 79 (April 15, 1929).—"Every analyst who has used a Hempel gas pipet knows how difficult it is when employing mercury in the gas buret to prevent such substances as alkaline pyrogallol, fuming sulfuric acid, etc., from running up the capillary tubing in the pipet and coming into contact with the rubber at the juncture between the pipet and the buret, when the level of the mercury in the buret and the leveling tube is being adjusted. Furthermore, as the gas is run back and forth through the pipet, droplets collect in the capillary tubing and these are frequently sucked back into the buret when the gas is being aspirated into it. The author has found that a small bulb about 0.5 cc. in volume blown in the capillary tubing, as shown in the accompanying sketch, causes these bubbles to be broken, and as it takes a few moments for the bulb to fill, one has plenty of time to level the mercury in the buret." M. W. G.



A Convenient Method for Preparing Na-K Alloy. *Ind. Eng. Chem., Anal. Ed.*, **1**, 75 (April 15, 1929).—"When maximum reactivity, at relatively low temperature, is desired of an alkaline metal, the liquid sodium-potassium alloy is very useful. The most common method of preparation is to melt the metals together under kerosene. This method is not satisfactory, for it tends to divide the alloy into small particles coated with dirt.

"The alloy is easily prepared by placing freshly cut sodium and potassium in slightly wet ether and slowly agitating. It keeps clean under ether, and may be pipetted from the bottom of the container in substantial purity. Although the alloy catches fire when exposed to air and must consequently be handled with care in the presence of

ether, experience has shown that this association is less dangerous than the association of the alloy with benzene, since the rapid evaporation of the ether has a cooling and a blanketing effect, which reduces the tendency of the alloy to ignite." M. W. G.

Aids for the Teaching of Science. J. H. JENSEN. *Sch. Sci. & Math.*, **29,** 203, 330, 444, 552 (1929).—Commercial firms willing to furnish material to science teachers are listed. The nature of the material—pamphlets, charts, exhibits, pictures, movie reel, lantern slides, etc.—is listed for each concern, together with the charges connected with such service. M. W. G.

Exhibitors at the Twelfth Exposition of Chemical Industries. *News Ed., Ind. Eng. Chem.*, **7,** 12–20 (April 20, 1929).—An alphabetical list of the exhibitors with notes characterizing the individual exhibits. M. W. G.

New Method for the Quantitative Determination of Ozone in Air. M. S. EGOROW. *Z. Unters. Lebensm.*, **56,** 355–64 (1928); *Analyst*, **54,** 189–90 (March, 1929).—"The method for the determination of small quantities of ozone in which the iodine liberated from potassium iodide is titrated with sodium thiosulfate solution is not sufficiently sensitive. The fluorescein method of Benoist [*Analyst*, **44,** 183 (1919)] has the disadvantage that the reaction is slow, and the ozone is destroyed, and the author suggests instead the formation of fluorescein from its non-fluorescent leuco-compound (fluorescin), by the action of ozone. Fluorescein (1 mg.) is dissolved in a few drops of 10 per cent sodium hydroxide solution, 10 cc. of a saturated solution of sodium hydroxide added, and the mixture shaken with zinc dust, and filtered when the disappearance of fluorescence indicates that reduction is complete. One drop of freshly made solution is placed in a test tube with 10 cc. of 0.5 per cent sodium hydroxide solution, and the ozonized air drawn through the liquid at a maximum rate of about 12 to 15 liters per hour by means of a graduated water-aspirator. If the tube is placed in an illuminated comparator, the flow may be stopped, and the volume of air measured when the fluorescence matches that of a standard solution containing 1 part of fluorescein in 100,000,000. The fluorescence is stable in alkaline solutions and is unaffected by hydrogen peroxide or oxides of nitrogen, and the method is sensitive, rapid, and specific. One part by weight of fluorescein is produced by 0.96 part of ozone." M. W. G.

Detection of Small Traces of Vanadium. A. FÖLSNER. *Chem.-Ztg.*, **53,** 259 (Mar. 30, 1929).—The ordinary test for vanadium consists of the treatment of the substance with hydrogen peroxide in a solution made acid with sulfuric or hydrochloric acid which produces a reddish brown solution if vanadium is present. This test fails completely if the quantity of vanadium is small. In such cases it is better to substitute lead acetate for hydrogen peroxide. The following two experiments are described:

Expt. No. 1. A mixture of iron turnings and 0.02% of vanadium was dissolved in hydrochloric acid and oxidized with nitric acid. Silicon dioxide was precipitated and iron oxide was removed with excess sodium hydroxide. One half of the alkaline filtrate was acidified with hydrochloric acid and treated with hydrogen peroxide. No coloration was observed. Manganous chloride was precipitated; the filtered manganese vanadate was dissolved in hydrochloric acid, evaporated to a small volume, and again tested with hydrogen peroxide with the same negative result. The same solution was then diluted to 300 cc., boiled to remove the hydrogen peroxide, and a little lead acetate was added to the acetic acid solution. This caused at once a distinct turbidity of the solution.

Expt. No. 2. A quantity of dissolved vanadium corresponding to 0.03% of the element was added to a solution of 300 cc. of water, 50 cc. of ammonium acetate, and 15 cc. of lead acetate. A faint but distinct turbidity was observed. The same quantity of vanadium when added to 350 cc. of a sulfuric acid solution of hydrogen peroxide produced no color. In the latter case, positive results were not obtained whenever the vanadium content was less than 0.1%. L. S.

The Preparation of Some Metallic Chromates. S. H. C. BRIGGS. *J. Chem. Soc.*, **1929,** 242–5.—Experimental procedures and data are given for the preparation of zinc, zirconium, aluminum, ferric, antimony, copper, cobalt, cadmium, and nickel chromates and of antimony and bismuth chromite. M. W. G.

The Synthesis of Magnesium Sulfide. L. DOERMER. *Z. physik. chem. Unterricht*, **42,** 70–4 (Mar., April, 1929).—A number of experiments proved that the synthesis of magnesium sulfide, calcium sulfide, or aluminum sulfide by heating a mixture of the corresponding metal with sulfur in a test tube is very dangerous. The hot mixtures are explosive and may cause serious accidents. Such experiments should be omitted from the laboratory work in courses of general chemistry. L. S.

Desicchlora (Anhydrous Barium Perchlorate). G. F. SMITH. *Chem. Analyst*, **18,**

18–24 (Mar. 1, 1929).—"In a previous paper (*Chem. Analyst*, **17**, 21–3 (Oct. 1, 1929)), a preliminary survey of the perchlorate drying agents of the alkaline earth metals was given. This paper (part I) was divided into four parts and consisted in the comparison of the desirable characteristics of anhydrous barium perchlorate $Ba(ClO_4)_2$ which distinguish it from the undesirable properties of anhydrous calcium chloride. The topics previously discussed were:

"1. The bibliography of the alkaline earth metal perchlorate drying agents previously described and at present widely and successfully employed.

"2. A classification of the various methods of preparation of barium perchlorate trihydrate by both wet and dry methods.

"3. An outline comparison of anhydrous barium perchlorate and calcium chloride including advantages and disadvantages in general dehydrating efficiency.

"4. Methods of testing anhydrous barium perchlorate (Desicchlora).

"The present paper deals with a more detailed discussion of the dehydration of barium perchlorate trihydrate in sufficiently pure form to pass the exacting tests given under part 4 above, the experimental data concerning its use as compared to anhydrous calcium chloride under exactly comparable conditions, tests of its stability for use in drying reducing gases, details concerning its reversible absorption of ammonia gas, and the discussion of its successful regeneration and porosity. It is understood that a comparison of Desicchlora and anhydrous calcium chloride takes into consideration only that form of the latter of comparable purity to the former, *e. g.*, the purified, white, granular, calcium chloride intended for use in desiccators." M. W. G.

Teaching High-School Chemistry. E. L. DONAHO. *Ala. Sch. J.*, **46**, 7 (April, 1929).—This is a resumé of a plan of procedure used by the author in her classes in chemistry in the Tuscaloosa (Ala.) High School. An attempt is being made to get away from the old textbook-recitation plan because the latter does not lead to effective study nor to a proper scientific attitude on the part of the student. The year's work is broken up into units and sub-units. Written directions are given which clearly state the method of procedure and the things which the student is to find out for himself. Individual work is emphasized. Class periods may be spent in working out difficulties which have confronted the class as a whole, discussion of special points to be brought out, special reports, etc. Considerable part of the period is used for supervised study. Review sheets covering each unit are given the pupil and ample use is made of illustrative material and field trips. Each pupil is given a special project during the semester. Results seem to justify the continuation of this plan of procedure. C. M. P.

Marking Systems in Teacher Training Institutions. H. L. ARNOLD. *Calif. Quart. Sec. Educ.*, **4**, 244–8 (April, 1929).—This paper summarizes the general status of marking systems in one hundred institutions in thirty-four states. Approximately 85 per cent of the institutions use letters in marking. The five-point marking system is used in practically the same percentage of schools. Fifty-nine per cent of the schools use some system of honor or quality points in connection with credits. About half of the schools make specific requirements for graduation in respect to quality points. There seems to be a marked tendency toward the requirement of a so-called "C" average for graduation. Comparatively few schools require that marks shall conform more or less to the normal curve of distribution. C. M. P.

KEEPING UP WITH CHEMISTRY

Thirty-Fifth Annual Report of the Committee on Atomic Weights. Determinations Published during 1928. G. P. BAXTER. *J. Am. Chem. Soc.*, **51**, 647–54 (Mch., 1929).—The work done during 1928 on K, Ti, Cu, Cs, Ba, Ag, Ce, Er, Re, Pb, and U is reviewed. In the accompanying table of atomic weights changes from the 1928 table are made in the cases of H, P, S, Ba, Ce, Er, K, Ra, Th, and U.

AMERICAN CHEMICAL SOCIETY ATOMIC WEIGHTS, 1929

	Symbol	At. number	At. weight		Symbol	At. number	At. weight
Aluminum	Al	13	26.97	Bromine	Br	35	79.916
Antimony	Sb	51	121.77	Cadmium	Cd	48	112.41
Argon	A	18	39.94	Calcium	Ca	20	40.07
Arsenic	As	33	74.96	Carbon	C	6	12.000
Barium	Ba	56	137.36	Cerium	Ce	58	140.13
Beryllium	Be	4	9.02	Cesium	Cs	55	132.81
Bismuth	Bi	83	209.00	Chlorine	Cl	17	35.457
Boron	B	5	10.82	Chromium	Cr	24	52.01

	Symbol	At. number	At. weight		Symbol	At. number	At. weight
Cobalt	Co	27	58.94	Phosphorus	P	15	31.02
Columbium	Cb	41	93.1	Platinum	Pt	78	195.23
Copper	Cu	29	63.57	Potassium	K	19	39.10
Dysprosium	Dy	66	162.46	Praseodymium	Pr	59	140.92
Erbium	Er	68	167.64	Radium	Ra	88	225.97
Europium	Eu	63	152.0	Radon	Rn	86	222
Fluorine	F	9	19.00	Rhenium	Re	75	188.7
Gadolinium	Gd	64	157.26	Rhodium	Rh	45	102.91
Gallium	Ga	31	69.72	Rubidium	Rb	37	85.44
Germanium	Ge	32	72.60	Ruthenium	Ru	44	101.7
Gold	Au	79	197.2	Samarium	Sm	62	150.43
Hafnium	Hf	72	178.6	Scandium	Sc	21	45.10
Helium	He	2	4.002	Selenium	Se	34	79.2
Holmium	Ho	67	163.5	Silicon	Si	14	28.06
Hydrogen	H	1	1.0078	Silver	Ag	47	107.880
Indium	In	49	114.8	Sodium	Na	11	22.997
Iodine	I	53	126.932	Strontium	Sr	38	87.63
Iridium	Ir	77	193.1	Sulfur	S	16	32.06
Iron	Fe	26	55.84	Tantalum	Ta	73	181.5
Krypton	Kr	36	82.9	Tellurium	Te	52	127.5
Lanthanum	La	57	138.90	Terbium	Tb	65	159.2
Lead	Pb	82	207.22	Thallium	Tl	81	204.39
Lithium	Li	3	6.940	Thorium	Th	90	232.12
Lutecium	Lu	71	175.0	Thulium	Tm	69	169.4
Magnesium	Mg	12	24.32	Tin	Sn	50	118.70
Manganese	Mn	25	54.93	Titanium	Ti	22	47.90
Mercury	Hg	80	200.61	Tungsten	W	74	184.0
Molybdenum	Mo	42	96.0	Uranium	U	92	238.14
Neodymium	Nd	60	144.27	Vanadium	V	23	50.96
Neon	Ne	10	20.183	Xenon	Xe	54	130.2
Nickel	Ni	28	58.69	Ytterbium	Yb	70	173.6
Nitrogen	N	7	14.008	Yttrium	Y	39	88.92
Osmium	Os	76	190.8	Zinc	Zn	30	65.38
Oxygen	O	8	16.0000	Zirconium	Zr	40	91.22
Palladium	Pd	46	106.7				

A. P. B.

Some Important Events of 1928. *Ind. Eng. Chem.*, **21,** 4–8 (Jan., 1929).—This article includes a brief description of the important accomplishments in chemistry during the past year. Notes on agreements and mergers, international meetings, important patent decisions, and medal awards are also included. M. W. G.

Progress in the Synthetic Organic Chemical Industry in 1928. F. TALBOT AND W. N. WATSON. *Ind. Eng. Chem.*, **21,** 8–11 (Jan., 1929).—Synthetic organic chemicals are subdivided into (1) aromatic or coal-tar derivatives and (2) aliphatic, or non-coal-tar derivatives. The most striking developments in the production of these chemicals during the past year are discussed briefly. M. W. G.

The International Temperature Scale. *Analyst*, **54,** 292–4 (May, 1929).—In 1911 the directors of the national laboratories of Germany, Great Britain, and the United States agreed to undertake the unification of the temperature scales used in their respective countries. This course was approved by the Fifth General Conference of Weights and Measures (1913), and at the Sixth General Conference (1921), it was decided to expand the field of activities of the International Committee and International Bureau, and to coördinate results obtained in other institutions. Finally, in 1927, the Seventh General Conference, representing 31 nations, adopted unanimously a resolution approving of the provisional adoption of an international scale, submitted for discussion by the Bureau of Standards, the National Physical Laboratory, and the Physikalisch-Technische Reichsanstalt.

The English text of the introduction and definition of the scale is as follows:

INTRODUCTION.—The experience of the Bureau of Standards, as of the National Physical Laboratory and of the Reichsanstalt, has for many years past indicated the necessity, for industrial purposes, of international agreement on a scale of temperatures ranging from that of liquid oxygen to that of luminous incandescent bodies. As a result of discussion extending over a considerable period, agreement has been reached

by the three laboratories, subject to possible minor drafting amendments, on the attached specification for a practical scale, as affording a satisfactory basis on which uniformity in certification of temperature measurements for industrial purposes may be maintained.

It is to be understood that this proposal does not purport to replace the absolute temperature scale which it is recommended should be adopted, on principle, by the International Conference on Weights and Measures. It is intended merely to represent this scale in a practical manner with sufficient accuracy to serve the everyday needs of the laboratories for the purpose of industrial certifications, and is to be regarded as susceptible of revision and amendment as improved and more accurate methods of measurement are evolved.

It is anticipated that this scale will shortly be adopted by the three laboratories for the purposes indicated, and the attached draft is presented to the conference for consideration, with the recommendation that it should be officially adopted, with such amendments, if any, as may be agreed on, as the best practical realization at the present time of the ideal thermometric scale.

PART I. DEFINITION OF THE INTERNATIONAL TEMPERATURE SCALE

1. The Thermodynamic Centigrade Scale, on which the temperature of melting ice, and the temperature of condensing water vapor, both under the pressure of one standard atmosphere, are numbered 0° and 100°, respectively, is recognized as the fundamental scale to which all temperature measurements should ultimately be referable.

2. The experimental difficulties incident to the practical realization of the thermodynamic scale have made it expedient to adopt for international use a practical scale designated as the International Temperature Scale. This scale conforms with the thermodynamic scale as closely as is possible with present knowledge, and is designed to be definite, conveniently and accurately reproducible, and to provide means for uniquely determining any temperature within the range of the scale, thus promoting uniformity in numerical statements of temperature.

3. Temperatures on the international scale will ordinarily be designated as "°C.," but may be designated as "°C.(Int.)" if it is desired to emphasize the fact that this scale is being used.

4. The International Temperature Scale is based upon a number of fixed and reproducible equilibrium temperatures to which numerical values are assigned, and upon the indications of interpolation instruments calibrated according to a specified procedure at the fixed temperatures.

5. The basic fixed points and the numerical values assigned to them for the pressure of one standard atmosphere are given in the following table, together with formulas which represent the temperature (t_p) as a function of vapor pressure (p) over the range 680 to 780 mm. of mercury.

6. Basic fixed points of the International Temperature Scale—

	°C.
(*a*) Temperature of equilibrium between liquid and gaseous oxygen at the pressure of one standard atmosphere (oxygen) point)	−182.97
$t_p = t_{760} + 0.0126\ (p - 760) - 0.0000065\ (p - 760)^2$	
(*b*) Temperature of equilibrium between ice and air-saturated water at normal atmospheric pressure (ice point)	0.000
(*c*) Temperature of equilibrium between liquid water and its vapor at the pressure of one standard atmosphere (steam point)	100.000
$t_p = t_{760} + 0.0367\ (p - 760) - 0.000023\ (p - 760)^2$	
(*d*) Temperature of equilibrium between liquid sulfur and its vapor at the pressure of one standard atmosphere (sulfur point)	444.60
$t_p = t_{760} + 0.0909\ (p - 760) - 0.000048\ (p - 760)^2$	
(*e*) Temperature of equilibrium between solid silver and liquid silver at normal atmospheric pressure (silver point)	960.5
(*f*) Temperature of equilibrium between solid gold and liquid gold at normal atmospheric pressure (gold point)	1063

Standard atmospheric pressure is defined as the pressure due to a column of mercury 760 mm. high, having a mass of 13.5951 g./cm.^{3}, subject to a gravitational acceleration of 980.665 cm./sec.^{2}, and is equal to 1,013,250 dynes/cm.^{2}.

It is an essential feature of a practical scale of temperature that definite numerical

values shall be assigned to such fixed points as are chosen. It should be noted, however, that the last decimal place given for each of the values in the table is significant only as regards the degree of reproducibility of that fixed point on the International Temperature Scale. It is not to be understood that the values are necessarily known on the Thermodynamic Centigrade Scale to the corresponding degree of accuracy.

7. The means available for interpolation lead to a division of the scale into four parts.

(*a*) From the ice point to 660° C. the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula

$$R_t = R_o(1 + A + Bt^2).$$

The constants R_o, A, and B of this formula are to be determined by calibration at the ice, steam, and sulfur points, respectively.

The purity and physical condition of the platinum of which the thermometer is made should be such that the ratio R_t/R_o shall not be less than 1.390 for $t = 100°$ and 2.645 for $t = 444.6°$.

(*b*) From —190° to the ice point, the temperature t is deduced from the resistance R_t of a standard platinum resistance thermometer by means of the formula

$$R_t = R_o[1 + At + Bt^2 + C(t - 100)t^3].$$

The constants R_o, A, and B are to be determined as specified above, and the additional constant C is determined by calibration at the oxygen point.

The standard thermometer for use below 0°C. must, in addition, have a ratio R_t/R_o less than 0.250 for $t = -183°$.

(*c*) From 660°C. to the gold point, the temperature t is deduced from the electromotive force e of a standard platinum vs. platinum-rhodium thermocouple, one junction of which is kept at a constant temperature of 0°C., while the other is at the temperature t defined by the formula

$$e = a + bt + ct^2.$$

The constants a, b, and c are to be determined by calibration at the freezing point of antimony, and at the silver and gold points.

(*d*) Above the gold point the temperature t is determined by means of the ratio of the intensity J_2 of monochromatic visible radiation of wave-length λ cm., emitted by a black body at the temperature t_2, to the intensity J_1 of radiation of the same wave length emitted by a black body at the gold point, by means of the formula

$$\log_e \frac{J_2}{J_1} = \frac{c_2}{\lambda}\left[\frac{1}{1336} - \frac{1}{(t + 273)}\right]$$

The constant c_2 is taken as 1.432 cm. degrees. The equation is valid if $\lambda(t + 273)$ is less than 0.3 cm. degrees.

Part II deals with the recommended experimental procedure for determining: (1) the temperature of equilibrium of liquid and gaseous oxygen; (2) the temperature of melting ice; (3) the temperature of condensing water vapor; (4) the temperature of condensing sulfur vapor; (5), (6), and (7) for standardizing a thermocouple; (8) subsidiary points. M. W. G.

The Rare Gases. R. B. MOORE. *Chem. Bull.*, **16,** 151 (May, 1929).—The distribution and origin of the rare gases are discussed—helium at some length. The U. S. has a monopoly on the helium supply from natural gas; natural gases in other countries seldom containing more than a few tenths of a per cent.

Three possible origins of rare gases are suggested: "radioactivity, extra-terrestrial, and the decomposition of ordinary elements."

A discussion of the chemistry of rare gases, including attempts to form chemical compounds, and a resumé of the occurrence of the rare gases and their extraction from the atmosphere are given.

Mention is made of the commercial use of neon and argon in signs. H. T. B.

Basic Industrial Minerals. VI. Magnesite. G. M. DYSON. *Chem. Age*, **20,** 376–7 (April 20, 1929).—"Magnesite is a broad term which covers almost a multitude of varieties of magnesium carbonate in various states of purity and physical condition." Enormous deposits of dolomitic magnesite exist, which at present are of little value owing to the difficulty of separating the calcium from the magnesium. More attention will be paid to this problem in the future owing to the increasing importance of metallic magnesium. E. R. W.

The Affinity of Sulfur for the Metals. C. FRICK. *Chem.-Ztg.*, **53**, 317–8 (April 20, 1929).—Most of the metals which the metallurgist has to prepare in a pure state occur combined with sulfur. Therefore it is his task to remove the sulfur by roasting. In order to choose the correct material he must know the affinity of sulfur for the metals. A number of investigators who have worked on this problem arranged the most important metals in series according to their affinity for sulfur. Their results do not agree. The various series are given in the table.

Fournet	Markus	Schweder	Thomsen Dürre	Ostwald	Guertler		Frick at 1200°C.
			Mn	Al	Mn	Mn	
				Mg			
				Mn	Al		
			Zn	Zn	Zn		Zn
Cu			Cd	Cd (As, Sb)	Cd	Cu	
Fe	Fe	Fe	Fe	Fe	Fe	Fe	
Sn		Cu	Co	Co			
Zn							Sn
Pb	Pb		Pb	Pb	Pb		Pb
			Cu	Cu	Cu		Cu
					Co	Ni	
		Ni	Ni	Ni	Ni	Co	
					Sb	Pb	
			Hg	Hg	Hg	Sb	
Ag	Ag		Ag	Ag	Ag	Ag	
Sb							
As							

The difference between the various series is due to the fact that the affinity of sulfur toward the metals changes greatly with temperature. The affinity of this element for Zn, Sn, and Pb may be greater at elevated temperatures than for Cu. For this reason the temperature should always be stated at which the series is determined.

L. S.

Arsenic: Its Occurrence, Properties, and Applications. *Chem. Age* (*Mo. Met. Sect.*), 25–6 (April 6, 1929).—Arsenic has been known since a very early date. Its occurrence as an element is of little importance, most of the commercial material is obtained from arsenic trioxide formed during the calcination of ores. The presence of as little as 0.05% of arsenic in copper lowers the conductivity 15%. Arsenic or its compounds are used in medicine, in the glass industry, and as insecticides. E. R. W.

The Production and Uses of Tartaric Acid. G. M. DYSON. *Chem. Age.*, **20**, 331–3 (April 6, 1929).—A very interesting article, telling something of the history of tartaric acid, its production as a by-product of the wine industry and its uses. Synthetic methods of preparing this acid have not yet been developed so as to be of industrial importance. The possibility of preparing glyoxal from carbon monoxide and water is pointed out. The glyoxal is readily converted to tartaric acid by treatment with sodium cyanide and subsequent hydrolysis of the dinitrile formed. E. R. W.

The Electrodeposition of Cadmium for Rust Prevention. S. WERNICK. *Chem. Age* (*Mo. Met. Sect.*), **20**, 17–8 (Mar. 2, 1929); 27 (April 6, 1929).—One of the most important developments in the plating industry is the advent of cadmium plating for use primarily as a rust preventive for ferrous material. The composition of the cadmium-plating solutions greatly influences the nature of cadmium deposit obtained. The results obtained by increasing, respectively, the cadmium content, the free cyanide content, and the alkali content are discussed.

The conditions necessary for a good deposit are discussed. Cadmium evidently affords better protection to metal surfaces than does zinc. Attempts to plate another metal, such as nickel, over the cadmium plate have not given satisfactory results.

E. R. W.

A Survey of Chromium Plating. *Chem. Age*, **20**, 354–5 (April 13, 1929).—A review of a paper presented by G. E. Gardam. Chromium may be successfuly plated from a solution containing 250 g. of CrO_3 and 2.5 g. of H_2SO_4 per liter. Chromium plating requires a high current density and the character of the deposit varies greatly with variations in the current density, temperature, and composition of the solution. Other factors influencing the character of the deposit are discussed. E. R. W.

The Significance of Symmetry in Chemical Combination. S. H. C. BRIGGS. *Chem. & Ind.*, **48,** 108–9 (Feb. 1, 1929).—A brief discussion of the coördination theory of Werner, and a plea for the retention of the original meanings of the words, "molecule" and "coördination." E. R.W.

The Physical Chemist in Search of Purity in an Impure World. E. COHN. *Chem. & Ind.*, **48,** 162–9 (Feb. 15, 1929).—*A Messel Memorial Contribution.* Recent experiments carried out in the van't Hoff laboratory are leading to the conclusion that every substance is capable of existing in several modifications. Carbon and sulfur are familiar examples, tin and antimony a little less familiar; even thallous picrate, silver iodide, cane sugar, have been found to exist in different forms.

In our attempts to prepare chemically pure material we ordinarily make use of recrystallization, sublimation, or electrolysis. "Now our experience has shown us that these are just the most suitable ways of obtaining metastable mixtures of different modifications of the substance required. While we are preparing the substance by the methods mentioned in a chemically pure state on the one hand, therefore, we are obtaining it on the other hand in a physically impure form, so that finally we determine the physico-chemical constants not of a single substance but of an ill-defined mixture of several modifications of that substance." E. R. W.

Silicates and Bread. *Silicate P's & Q's*, **9** (May, 1929).—"Who would suspect that the molten soluble glass from a silicate furnace or the sticky liquid which comes from the dissolver would have any importance in connection with foodstuffs or particularly the staff of life."

Yeast can be least expensively grown in waste products from the sugar industry. These products, however, contain impurities that both discolor and disflavor the yeast. Long and scientific study has revealed that silicate of soda can greatly aid the removal of the objectionable impurities in the sugar waste and thus make it acceptable for yeast culture.

Five standards which the solution from sugar waste products must meet if it is to be satisfactory for growing yeast are enumerated. Silicate treatment gives a product meeting all five of these demands and in addition "yields a yeast that will mature in a shorter time and will give a better loaf than yeast grown in grain solution." B. C. H.

Capital + Vision + Research = An American Potash Industry. P. D. V. MANNING. *Chem. & Met.*, **36,** 268–72 (May, 1929).—This article contains a description, with illustrations, of the process and apparatus used for obtaining potash and borax at the Searles Lake Plant of the American Potash and Chemical Corporation. M. W. G.

Recent Developments in the Manufacture of Sulfuric Acid. S. F. SPANGLER. *Ind. Eng. Chem.*, **21,** 417–21 (May, 1929).—The changes in the use of sulfuric acid during the last few decades have led to modifications in the process of its manufacture. These developments are discussed rather fully and major problems still unsolved are indicated. M. W. G.

The Use of the Immersion Refractometer in Milk Analysis. G. D. ELSDON AND J. R. STUBBS. *Chem. Age*, **20,** 271–3 (Mar. 23, 1929).—A complete outline of several methods of preparing milk for inspection with the refractometer in order to determine whether or not water has been added to the milk. The refractometer study will enable one to decide between a good milk and a poor milk. It will not, in general, decide between a poor milk and a good milk which has had water added to it. E. R. W.

Some Properties of Flame and Combustion. W. E. GARNER. *Chem. & Ind.*, **48,** 186–9 (Feb. 22, 1929).—Evidence supports the idea that the emitters of radiation in a gas flame are the molecules of carbon dioxide and water. The question is raised as to whether this emission is due solely to the fact that the gases are heated, or whether at least part of it is due to chemi-luminescence. The results of the experiments described seem to indicate that both of these phenomena play a part in the emission of the light. E. R. W.

The Coloring of Rubber. *Chem. Age* (*Dyestuffs Mo. Suppl.*), **20,** 27–9 (April 13, 1929).—A review of a paper presented by W. J. S. Naunton. The drastic treatment to which rubber is subjected during vulcanization makes the problem of coloring rubber a difficult one. A general outline of the methods which have been used to color rubber of different types. E. R. W.

The Rôle of Surface Energy in Chemical Engineering. W. E. GIBBS. *Chem. & Ind.*, **48,** 127–37 (Feb. 8, 1929).—A very interesting discussion of the important phenomenon of surface energy and its relation to engineering practice. See abstract, J. CHEM. ED., **6,** 986 (May, 1929). E. R. W.

Olives, Ripe or Green. L. G. GRAVES. *Pract. Home Ec.*, **7,** 137 (May, 1929).—In preparing ripe olives the fruit is allowed to ripen on the tree. As they have an extremely

bitter taste, they are processed to remove this and develop a "smooth, oily, nut-like" taste. The essential process involves the use of several alkaline solutions followed by rinsing with water and soaking in numerous brines. The alkaline action must be carefully controlled so that none of the olive oil is saponified. The color change from green to brown is due to oxidation of the skin pigment.

Green olives are produced in regions which are infested by the "olive fly," and the fruit must be picked before this fly destroys it. They are bitter, tough-skinned, and hard when picked. They are treated with alkaline solutions (whose formulas are kept secret), washed, soaked in a pickling solution of salt, vinegar, and spices and are then ready for bottling.

Comparative food values are shown by the table.

	H_2O	Protein	Fat	Carbohydrate	Ash	Cal. per lb.
Olive, ripe	69.90%	2.00%	21.00%	4.00%	3.40%	958
Olive, green	78.41%	2.43%	12.90%	1.78%	4.48%	598

J. W. H.

Dates—A Healthful Sweet. L. G. GRAVES. *Pract. Home Ec.*, **7**, 115 (April, 1929).—Dates may be classed as concentrated food due to the amount and kind of sugar present. These sugars determine their nutritive value, keeping qualities, and classification. They are classed as invert sugar and cane sugar types, the invert sugar type having passed through a cane sugar stage before it was acted on by the enzyme invertase which it contains. The greatest influx of sugar into the date takes place shortly before ripening, hence they cannot be artificially ripened into an economic product before a certain minimum accumulation of sugar takes place. Premature ripening may be induced in some varieties by the action of CO_2 or heat. Most of the tanning is deposited as insoluble grains in a zone of tannin cells near the cuticle.

Protein, minerals, and vitamins are present only in small amounts.

Dates are readily digested and assimilated and may be utilized alone or in combination with other food materials. J. W. H.

HISTORICAL AND BIOGRAPHICAL

The Story of Bottles. *Crucible*, **13**, 26–7 (Feb., 1929).—"The art of making bottles is an ancient one—very ancient indeed. In fact, it is as ancient as man's desire to preserve or store something of value to him which he could not use at the moment. It is very reasonable to suppose, therefore, that one of the very first contrivances of the earliest civilized man was some kind of receptacle which we can safely term the ancestor of the modern bottle.

"The first mention of a receptacle of this kind is in the Bible. It was apparently the hide surrounding a goat's leg, sewed up so that the 'foot part' would be the nozzle. In some parts of the civilized world today, leather bottles of this same type are used for aging and preserving rare wines.

"Archaeologists tell us that bottle-making was highly developed among the ancient Egyptians and Phoenicians. According to Pliny, a Roman historian, it was a crew of Phoenician mariners that first discovered glass. They were transporting a boatload of nitre, and one evening accidentally used a few cakes of it to support their pots and pans in cooking a meal. The heat of the fire melted the nitre, which dripped on the sand of the seashore. All the elements necessary to produce glass were thus present, and the Phoenicians were quick to appreciate this new material. They established a glass factory on the very shores where their discovery was made.

"In medieval times, too, the art of glass making flourished. Venice is still noted for its genius along this line, which dates back to the early ages of the 'Dark Ages.' Many of the bottles made in ancient times were far more artistically and carefully wrought than we can imagine today. The intricacy of the ornamentation, the delicacy of the colors, and the skill in shaping entitle the bottle-makers of old to a very exalted position in the history of their profession.

"But we are more definitely interested in bottle-making in the United States, which has certainly made tremendous strides in relatively few years, considering the length of time the craft was known to the world.

"The first industrial enterprise established in the United States was a glass bottle factory. It was founded in 1607, about a mile from the colonial settlement of James-

town, Va. Coarse bottles and other articles of glass were being manufactured at Salem in 1639. And it is quite certain that a glass factory was in operation at Philadelphia in 1683.

"In New York City, two factories were making bottles in 1732, one in Connecticut in 1747, and another in Brooklyn in 1754. In 1738, Casper Wistar imported four skilled workmen from Rotterdam for his plant in Allowaystown, New Jersey.

"In the year 1770, a notice in the "Pennsylvania Chronicle and Universal Advertiser" offered a reward of $20 for 'two German servant lads run away.' One of these lads was described as 'Jacob Stenger, aged eighteen years, five feet eight inches, well set, good countenance, light complexioned, dark hair.'

"This incident is of interest in the history of early glass-making because it was this same Jacob Stenger, runaway, who five years later, in 1775, started the first glass plant that has survived to the present day—the factory known until 1918 as the Whitney Glass Works, at Glassboro, N. J.

"What a thrill this runaway German servant lad would get if he could see for only a moment the batteries of automatic machines that turn out thousands of bottles a day—if he could watch one of these clanking monsters, its sixty bottles a minute lifted from its opening molds by its ghostly steel fingers—a tribute to what America has done by encouraging its own manufacture!

"The name Whitney Glass Works existed until 1918, when the factory was absorbed by the Owens Bottle Co. of Toledo, Ohio.

"Now let us turn to one of the most fascinating fields in the history of the glass industry—the story of antique bottles in the United States. One could almost write a history of this country by studying the bottles it has produced. And a very human, sparkling history it would be—a history of the people and their habits and what they were thinking about.

"During the first seventy years of the nineteenth century, fancy pocket flasks and bottles were made in the United States. The best test of a bottle made in this period is the scarred base and sheared neck. The neck was sheared with scissors, leaving it irregular, and on the base was a rough circular scar, left by breaking the glass from the pontil or iron rod, which held the bottle, while it was being finished by the workman.

"Twenty-nine known flasks bear ornaments of an American Eagle, nineteen bear ornaments of the head of Washington, and twelve of the head of Taylor.

"The shapes varied. The earliest were slender and arched, with edges horizontally corrugated. Then came oval shapes, with edges ribbed vertically. The next pattern was almost circular in form with plain rounded edges. These were followed by the decanter shape, almost spherical, with long slender neck finished with a cap at the top, and having a scarred base.

"Among the old American bottles are the Kossuth and Jenny Lind flasks, made about 1848. One of Taylor's bottles has inscribed on it the historic command of General Taylor at the Battle of Buena Vista—'A little more grape, Captain Bragg!' Most of these early bottles show a delightful and typical American sense of humor—the humor of a people that were intensely proud of their achievements as the pioneers of a wonderful country, and were not inclined to mince words or apologize for anything.

"One of the oldest forms known to have been decorated in this country is one bearing the design of the first railroad, represented by a horse drawing along rails a four-wheeled car loaded with cotton bales and lumps of coal, and probably refers to the opening of the Baltimore and Ohio Railroad Company in 1830, then a road fourteen miles long!

"Then there are the log cabin designs, connected with the 'hard cider' campaign of William Henry Harrison in 1840. These dark brown and green whiskey bottles were made in New Jersey by the Whitney Glass Works for a Philadelphia distiller named E. C. Booz.

"It is from this man's name that we get the word 'booze,' a word that has since become synonymous with the word 'whiskey' in the American vernacular. How long it will yet survive in active use is a matter for speculation. Our own conjecture is that perhaps in less than a quarter century it will follow, along with other words pertaining to the good old bibulous days, into the limbo of forgotten usage, and become an antique along with the bottles that made it so famous.

"E. C. Booz was active in the Harrison Presidential campaign of 1840, and had bottles for his whiskey made in the shape of log cabins, the Harrison symbol. These bottles were eight inches high, and supposed to hold one quart. They have since brought large prices as antiques, being purchased by collectors who find bottles an interesting hobby.

"There are also Jackson bottles, representing the 'Hero of New Orleans' in a collar that completely covers his ears. These bottles belong to an earlier period, the 'stormy thirties.'

"In the later sixties, bottles made their appearance decorated with star, sheaf of wheat, rake, and pitchfork. Another showed an Indian with bow and arrow shooting a bird in the foreground. Other bottles were decorated with horns of plenty, flowers, panels of fruit, and one with a Pike's Peak Pilgrim, commemorating the passage of the Rocky Mountains.

"Bottles were very little used for the preservation of foods before 1857, the year in which the Mason screw top jar made its appearance. The old type preserving jars would provoke a laugh from the modern housewife. And so would the old medicine bottles. Their shapes are nothing short of grotesque.

"Some of the veterans of the industry may still recall a few of the names blown into these old bottles—D. S. Hart Sugar Coated Nervous Pills—'Bonum de Superb'—Macassar Oil (London) 'For the Hair'—H. W. Seat, M.D., Negative Electric Fluid—Dr. Marshall's Catarrh Snuff—Dr. B. Olens, Life Bitters, and many other long since shrouded in oblivion.

"A few of the freak bottles of this early period are very interesting. One is in the shape of the Baltimore Monument, with each brick faithfully reproduced. Another, the 'Toby Bottle,' is blown in the shape of a squat plump, cheery old fellow with a plug hat whose top is the mouth of the bottle. Another is blown in the shape of an erect Russian Bear, inviting you to take a drink of Russian Kimmel. Another shows Moses Smiting the Rock, another is an Indian very similar to the 'Cigar Store Indian' of the late nineties and early twentieth century—and so on.

"When compared with our present-day efficiency in design and production, some of these older products of the industry seem very primitive. But for the stories they tell and the pictures they leave with us of the people in whose midst they performed useful service, they remain priceless testimonials to the development of a great industry. —Reprinted by permission from *Bottling and Package Engineer.*" M. W. G.

Matches. A. S. MOFFETT. *The Ray of Gamma Sigma Epsilon*, **5**, 25–7 (Nov., 1928).—"Our present means of creating fire by the aid of a match is one of the most useful of human inventions. The development of the present-day match is a striking example of the application of scientific, especially chemical, knowledge to human needs.

"Chemical matches were introduced in 1807 and known as 'chemical tinder.' These were made by dipping small sticks or splints into melted sulfur and treating one end of them with a mixture of potassium chlorate and sugar. This first chemical match was ignited by dipping it into a bottle containing asbestos soaked in sulfuric acid. The acid caused a rapid decomposition of the chlorate, and kindling of the sulfur and sugar. From this primitive, yet scientific discovery, the modern friction and safety matches have been evolved.

"The invention of friction or lucifer matches by John Walker in 1827 in England was a great improvement over the former so-called chemical matches. The head of this first friction match was composed of a mixture of antimony tri-sulfide and potassium chlorate, made into a stiff paste with water and gum. This match was ignited by being drawn over sand paper with some pressures. The great value of this friction match was the way in which it was ignited.

"The substitution of phosphorus for the less easily oxidizable antimony-trisulfide in the mixture making up the head of the match was successfully accomplished by Dr. Charles Sauria in the early thirties of the nineteenth century. The introduction of white phosphorus was successful in solving the problem of producing fire at will but it had disadvantages as it caused much suffering among the matchworkers on account of the 'phosphorus disease,' as it was called, which the white phosphorus caused. This disease was a curious affection of the jaw bones and resulted in necrosis. This evil existed, however, and white phosphorus was used until 1898, when a substitute was found in the non-poisonous sesquisulfide of phosphorus. The use of white phosphorus is forbidden by law in Sweden, France, Great Britain, and Switzerland now and it is prevented by a tax of 2 cents per hundred matches in the United States.

"At the present time the head of the 'strike anywhere' match is composed of lead peroxide, red lead, or manganese dioxide, which supplies oxygen, and a small proportion of the sesquisulfide of phosphorus, which is readily ignited by friction, and dextrin or glue. They are prepared in the following manner:

"Soft wood, generally pine or spruce, is cut by machines into small sticks and these are thoroughly kiln-dried. The sticks are then placed in a frame so that each stick stands alone, and then the end of each stick is soaked in paraffin, melted sulfur or stearic

acid. The paste forming the head of the match is made by slowly stirring the phosphorus sulfide into a warm solution of dextrin or glue and then adding the oxidizing materials and stirring the mixture until it is cold. The paste may be colored with ultramarine, lead chromate, chalk, or lampblack according to the color desired for the head. The paste is then spread in a thin layer and the prepared sticks dipped into it once or twice. After drying, the sticks may be coated with thin shellac or other varnish to protect them from moisture in the air. To prevent the burned match stems from afterglowing or smouldering, the sticks are sometimes soaked in a solution of magnesium sulfate or ammonium phosphate and then dried before they are dipped into the paste forming their heads.

"The safety match is in some ways a big improvement over the 'strike anywhere' match. In some cases it is not as convenient as the latter, but the former must be struck on the box to be ignited and this insures against many of the accidental 'setting-offs' of the 'strike anywhere' match. The book matches are safety matches where cardboard strips have been substituted for the wooden sticks.

"The mixture for the head of the safety match is not easily ignited by itself. The head is composed of potassium chlorate or dichromate as the oxidizing material, some sulfur or antimony trisulfide, which is combustible, and a little powdered glass to increase the friction, all held together with glue.

"The surface upon which the safety match must be struck is coated with a thin layer of antimony tri-sulfide mixed with red phosphorus, chalk or powdered glass, and glue. The friction of the match head on the prepared surface of the box develops sufficient heat to convert a little of the red phosphorus into white phosphorus, which at once combines with some of the potassium chlorate and antimony trisulfide, evolving enough heat to ignite the mixture on the head of the match.

"Today matches have reached such perfection that it would be hard to say just what improvements will be made in them in the coming years. The usefulness and convenience of our present-day match was made possible through the untiring efforts of our chemists, throughout Europe and this country, in carrying on numerous experiments and observations." M. W. G.

Michael Faraday. F. L. BISHOP. *J. Eng. Educ.*, **19,** 790–802 (April, 1929).—An interesting account of the life and accomplishments of this "greatest experimental philosopher the world has ever seen." M. W. G.

Studies in Chemical Patent Procedure. I. Hall Patents for Aluminum Production. L. VAN DOREN. *Ind. Eng. Chem.*, **21,** 120–4 (Feb., 1929).—A brief review of the aluminum industry and of the development of the Hall process in this country and the independent development of the same process by Héroult in France are given. In order to give the chemist a better understanding of the procedure involved in the granting of patents, the Hall patents (including the application for and granting of the patents, and infringement proceedings) are discussed in detail. M. W. G.

Michelson's Economic Value. R. A. MILLIKAN. *Science*, **69,** 481 (May 10, 1929).—An "address delivered at the dinner of the Society of Arts and Sciences held in New York on February 22, 1929, upon the occasion of the presentation of the gold medal of the society to Messrs. Michelson and Millikan." G. H. W.

EDUCATIONAL MEASUREMENTS AND DATA

Individual Differences. *Res. Bull. Nat. Educ. Assoc.*, **7,** 67–74 (Mar., 1929).—The paper discusses the implications of individual differences, methods for recognizing and utilizing them, and the principal's responsibility in using superiorities of children to advantage. The Batavia plan, ability grouping, Winnetka plan, and Dalton plan are briefly described and with some, strengths and weaknesses suggested. The discussion concerns itself chiefly with homogeneous grouping, individual instruction and provision for the gifted child. The results of a comprehensive study of homogeneous grouping made by Worlton in Salt Lake City are summarized, the advantage being in favor of the grouping. Provision for the gifted child is almost untouched. Methods for finding and providing for such are given. The principal must become informed as to the extent, meaning, etc., of individual differences and then be familiar with methods for providing for these differences. He has an obligation to parents to inform them of strengths in their children and in some cases of weaknesses.

Tables are presented and an extensive bibliography. S. R. P.

College Rank and Success in Life. J. M. MORTON, JR. *Bull. Am. Assoc. Univ. Profs.*, **15,** 299–302 (April, 1929).—College rank is gaged in this article by graduation from Harvard either, without distinction, *cum laude, magna cum laude,* or *summa cum laude.* Success is measured by nomination either for the Board of Overseers or

Board of Directors of Harvard University. Of the first group, 368 in number, 67.6 per cent took degrees without distinction, 24.7% took degrees *cum laude*, 6.8% took their degrees *magna cum laude* and none were from the *summa cum laude* group.

Conclusions drawn: extreme scholarship has qualities associated with it which "are a positive hindrance and drawback. When scholastic requirements are pushed beyond a certain point the boys who might become our most valuable men are either excluded at the start or are so driven to keep up that they lose the very qualities on which success and usefulness depend." B. C. H.

THE METHODS AND PHILOSOPHY OF EDUCATION

The Search for an Educational Program. H. G. HULLFISH. *Educ. Admin. & Superv.*, **15,** 250–8 (April, 1929).—A discussion of the topic "Where Does One Go for Fundamental Assumptions in Education?" This topic was the subject of four papers read at the Boston Meeting of the Department of Superintendence of the National Education Association a year ago. Two views are contrasted—the psychological and the philosophical basis for curriculum construction. The writer contends that Freeman is wrong in stating that psychology can designate assumptions upon which an educational program can be based and that Freeman, while saying that philosophy cannot set fixed norms or standards, nevertheless in his own method sets inflexible norms or standards, though he does not call them such.

Curriculum construction involves the pitting of one assumption or set of assumptions against others and this is the province of philosophy. Present-day educational philosophy realizes that values and assumptions change. S. R. P.

Home Study. W. J. O'SHEA. *School*, **40,** 573–4 (April 25, 1929).—The superintendent of New York City's schools favors home study for pupils from the fourth grade and above. However he would limit such study in the fourth grade to not more than one lesson per day with not more than thirty minutes for its preparation and would increase both the number of lessons and time consumed in such preparation with the school age of the pupil.

He warns his teachers that such work should never be assigned as a punishment and that its worth to the pupil depends to a large degree upon the care exercised in its assignment and the fidelity with which the teacher follows up such assignments. Some considerable space in the article is devoted to methods of making such assignments. B. C. H.

The Excursion Project. F. F. GAITHER. *Educ. Screen*, **8,** 104 (April, 1929).—The excursion project is defined as "any type of project that lends itself to investigation, exploration, and gaining knowledge by first-hand contact with life, the individuals, environment and the world at large."

Suggested steps in preparing for taking and following up the excursion are: (1) Reading and discussing reference material, (2) formulating questions not answered in reading material, (3) the visit, (4) after-discussion of reference material and the excursion.

Such projects may be used in the natural sciences, geography, community civics, history, and even in literature and mathematics.

The plan for the excursion is best worked out with the group that is to make the trip. After it has been formulated it should be mimeographed so that each member may have a copy for use throughout the excursion.

An important after-activity following the excursion is seeking to answer the question, "Just what did we get out of this excursion any way?" B. C. H.

Improving the Work of the Public Schools through Group or Departmental Meetings. H. W. EMSWILER. *Ohio Teacher*, **49,** 343–4 (April, 1929).—Discussion of a plan of indirect supervision through group teachers' meetings as tried out in Starling Junior High School, Columbus, Ohio. Several interesting features of the plan are described which are suggestive of other methods. S. R. P.

Improving the Work of the Schools through the Parent-Teacher Association. W. C. DYER. *Ohio Teacher*, **49,** 345–6 (April, 1929).—A description of the work done by the Parent-Teacher Association of Columbus and Franklin counties. Some of the valuable aspects of the program are the furnishing of reading lists, books, and cases to schools; the establishment of branch libraries; dental clinics; student aid funds; parental education; and school and city beautification. S. R. P.

The Value of Education from the Character and Citizenship Point of View. W. O. THOMPSON. *Ohio Teacher*, **49,** 353–4 (April, 1929).—An address given before the Ohio State Educational Conference. The writer discusses the citizen's conceptions of education, character, and citizenship and what the citizen expects from teachers and the

school. The finest elements of education are said to come from personal contact and teachers must prepare the mind for the future and not merely for the satisfaction of immediate standards. S. R. P.

THE PHILOSOPHY OF SCIENCE

Life as the Chemist Sees It. B. C. HENDRICKS. *Neb. Educ. J.*, **9**, 258 (May, 1929).—Life, as the chemist sees it, invites participation. This may be either in the form of adapting natural offerings or in the downright creation of new substances unknown in nature. In this phase of his work the chemist has both duplicated and improved upon nature.

Constant thinking, which involves unseen entities, has habituated the chemist to have high regard for the invisible behind life's outward manifestations.

In the law of conservation of weight and energy, he has recognized constancy and a perpetuity, two very desirable attributes of nature's workings. H. T. B.

THE TEACHING PROFESSION

Research in Teacher Supply and Demand. B. R. BUCKINGHAM. *Educ. Admin. & Superv.*, **15**, 259–68 (April, 1929).—The writer bases his views and conclusions upon facts gathered from several states. The supply of and demand for teachers must be based upon considerations of quality as well as quantity. The latter is too frequently the sole object of study. Shift the demand to quality and there is always an undersupply of teachers. Every state should have at least a two-year training period with a four-year goal in the near future. There should be no discrimination between grade- and high-school teachers, rural, and city teachers.

The problem should be attacked from two sides, educational guidance and distribution. The former is the work of the training school in possession of necessary facts, the latter the work of a carefully organized and equipped central agency.

A stimulating and informative discussion. S. R. P.

The Evaluation of Supervision. R. D. LINDQUIST. *Educ. Admin. & Superv.*, **15**, 301–10 (April, 1929).—A study to determine to what extent principles and procedures set up by the Supervisory Group in the Oakland, California, schools are understood and approved of by the teachers and suggestions from the teachers for improvement of supervisory relations.

Data are presented to bear upon: (1) principals' meetings with teachers, (2) supervisors' meetings with teachers, (3) principals' classroom visitation, and (4) supervisors' classroom visitation. The information for the data were collected from questionnaires.

Some of the conclusions presented are: (1) Teachers are keenly aware of principals' limitations in regard to planning of meetings. (2) Teachers prefer the discussion method in supervisors' meetings with teachers and prefer teacher-demonstration as a basis for discussion. (3) Teachers feel that the topics discussed in supervisors' meetings with them are too general. (4) Teachers have not learned through experience to what extent the principal can help them. (5) Teachers do not understand and appreciate the function of the supervisor as a teacher of teachers. S. R. P.

Examples of Scientific Procedure in Supervision. C. H. JUDD. *Calif. Quart. Sec. Educ.*, **4**, 194–200 (April, 1929).—In reply to the question, "Did supervision (by the principal) which you received last year make you a better teacher?" fifty-three Michigan teachers said "Yes" and fifty-one said "No." Indications are at hand that principals are critically examining their own successes and failures. The school is a coöperative enterprise and supervision to be truly scientific must recognize the justice of distributing responsibility. Scientific evaluation means more than measurement. Valid explanations as well as facts are necessary. Scientific procedures in self-supervision of pupils, and in teacher selection and management are needed. Scientific supervision depends on comprehensive understanding. C. M. P.

Problems in the Appraisal of Supervision. S. A. COURTIS. *Educ. Admin. & Superv.*, **15**, 269–78 (April, 1929).—A thoughtful discussion of the problems involved in the really valuable and careful appraisal of supervision.

The quality and quantity of supervision must be determined in terms of philosophy, form of organization, and form of execution. Extreme examples are given of each of these three elements. The two extremes of philosophy are those of efficiency and those of growth. The extremes under form of organization are the compartmental and the functional. The form of execution may be autocratic or democratic. These phases of the appraisal of supervision present their subsidiary problems.

Concerning the results of supervision they must be measured in terms of the philosophy of preparation for life or that of integration and growth of personality.

The appraisal of supervision involves the study of the operation of supervisory activities, the effect upon the teacher, and the effect upon the students. Supervision may not be said to have been measured until it is expressed as rate of change in growth per unit of supervisory effort executed. S. R. P.

The Academic Mind. H. J. LASKI. *Harper's*, **1929,** 593–601 (April).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

Great Teachers and Methods of Developing Them. R. L. KELLY. *Assoc. Am. Coll. Bull.*, **15,** 49–67 (Mar., 1929).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

The Improvement of College Teaching as an Administrational Problem. R. E. TULLOSS. *Assoc. Am. Coll. Bull.*, **15,** 73–89 (Mar., 1929).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

College Teaching—Uses and Abuses of Standardization. F. W. REEVES. *Assoc. Am. Coll. Bull.*, **15,** 230–41 (May, 1929).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

Who Is a Great Teacher? G. E. SNAVELY. *Assoc. Am. Coll. Bull.*, **15,** 68–72 (Mar., 1929).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

Technics Used in Dealing with Certain Problems of College Teaching. A. W. NOLAN. *Univ. Ill. Bull.*, **26,** No. 40 (June 4, 1929).—See Digest—College Teaching—THIS JOURNAL, **6,** 1341 (July-Aug., 1929). M. W. G.

MISCELLANEOUS

Courtesy among Scientists. EDIT. *Chem. Bull.*, **16,** 161 (May, 1929).—It is seldom that scientists are guilty of deliberate falsification, but "preconceived opinions frequently lead to inaccuracies of observation or of interpretation of results."

"Often differences between scientific researches are more apparent than real." It would be far better for a scientist who disagrees with the results of another to correspond directly with the erring worker. Much ill feeling might be avoided in this way.

Let the man who has erred be given the first opportunity to correct the mistake in print. This would be no more than the common rules of courtesy. H. T. B.

Chemistry as a Profession. J. W. SHIPLEY. *Can. Chem. & Met.*, **13,** 48–53 (Feb., 1929).—An address delivered before the Quebec Section of the Canadian Institute of Chemistry, at Montreal, Jan. 3, 1929. A brief survey of the industrial expansion in Canada during the past few years is given. Numerous opportunities for the competently trained chemist are pointed out. M. W. G.

The Activities of a Research Scientist in the Government Service. A. L. WILLISTON. *Educ. Rec.*, 126–31 (April, 1929).—This article is a description of the way in which a study is being carried on to determine the nature of the activities and requirements for successful performance of research scientists in government service. A "job analysis" of a position in the Bureau of Standards has been made. This record, called a "Record of Performance" when transcribed, covered about 140 typewritten pages. A summary of this analysis is included in the article. C. M. P.

Engineering Development and Research. L. A. HAWKINS. *Gen. Elec. Rev.*, **32,** 86–94 (Feb., 1929).—Engineering development is described as a "very ancient human activity. Research is a much newer thing. It was unknown in American industry at the beginning of the present century."

Research is defined as "an exploration, a systematized search" without reference to application of that which is found. So "pure research" and "applied research" are equally misnomers.

Research has, by some engineers, been confused with testing. Testing is essentially "the application of existing knowledge to the problems of industry—research need have no connection with industry."

Three problems need to be met by the industry contemplating research: type of research to be attempted, the relation of the research staff to the rest of the organization and the personnel of that staff.

Types of research are characterized as "intensive" and "extensive." The first dealing with a very limited field such as the improvement of tungsten filaments for the incandescent lamp; the second concerned with fundamentals with no immediate practical objective, such as the study of tungsten's properties in general. The studies which

led to the discovery of the "atomic hydrogen flame" and its ultimate use in welding were of the second type.

The director of research may be over both the research and the engineering laboratory or the two laboratories may be separated with the research division virtually independent. Conditions making the one or the other type of organization desirable are considered. Coöperation within the laboratory itself and rewards for discoveries made and the necessity for adequate records receive attention.

Characteristics of the research type of personality are summarized as: "an intellectual restlessness; the ability to see wonders in the commonplace; quick perception of, and interest in, the exceptional; a high optimism; and a philosophical imagination."

The author declares, "For the man with real aptitude and requisite training, research is by far the most attractive field I know," not necessarily because of financial rewards "but in his work he shares with the artist the joy of creation, with the explorer the thrill of continual new discovery, with the scholar the zest of intellectual struggle and the triumph of intellectual achievement, and with the philanthropist the satisfaction of contributing to humanity's welfare." B. C. H.

Canadian National Research Council Report for 1927-28. *Chem. Age*, **20,** 462 (May 11, 1929).—"The report of the Canadian National Research Council, Ottawa, for the official year 1927–28, indicates that, in addition to its general responsibilities, the National Research Council is assigned by the Research Council Act the duties, among others, of promoting the utilization of Canadian natural resources; conducting researches into industrial technical processes and methods; investigating and determining standards and methods of measurements, etc.; standardizing of scientific and technical apparatus and instruments, and determining standard of quality of materials used in public works construction and the Government service; and making researches for the improvement of agriculture.

The work of the Council during the past year included the organization and stimulation of coöperative research work on major problems through associate research committees; stimulation of research work by research grants for special equipment or technical assistance to qualified research men working in established laboratories and post-graduate training of research workers by the award of graduate scholarships in science and research to graduates who have completed a university course in science with distinction.

At the close of the year there were organized, under the National Research Council, 24 associate committees with a total membership of 363, all of whom gave their time and experience without remuneration. There were also in active operation in laboratories from coast to coast 88 specific investigations, each directed without remuneration by a highly trained specialist. At the same time 48 post-graduate research scholarships were also in active operation under the Council's auspices with the object of training outstanding university graduates in science and research, in order to build up in Canada a corps of men thoroughly qualified to undertake such work.

The total research organization actively at work under the National Research Council numbered 570, of whom 465 persons served without remuneration. Since the close of the official year 750,000 dollars has been provided by the Canadian Parliament as an initial vote for the erection of national research laboratories. E. R. W.

Educational Books of 1928. J. L. WHEELER. *Sch. & Soc.*, **28,** 803–15 (Dec., 29, 1928).—This list of over four hundred titles includes publications of 1928 on teaching, school administration, and educational research. This list was submitted to 200 specialists who compiled the annual selected list of sixty educational books for the *J. Nat. Educ. Assoc.* (see the March issue, pp. 95–8). A comparison of this list with similar ones of previous years will enable one to study the trends of educational literature.

The books are classified under 23 headings as follows: Purposes, Principles, and Philosophy of Education (*General*); Administration and Supervision; General Surveys and Statistics; Curriculum; Conduct and Character Formation; Educational Psychology; Intelligence Tests and Measurements; Exceptional Children; Educational Research; Teachers and Teaching Methods; Pre-School, Kindergarten, and Elementary Schools; Junior High School; Secondary Education; Reading, Writing, Languages, and Literature; School Libraries; Mathematics and Science; Social Studies, Arts, and Music; Vocational; Health and Physical Education; Extracurricular Activities; Rural Education; Higher Education; Adult Education. M. W. G.

Local Activities

Through these columns, the JOURNAL desires to render a two-fold service.

1. Keeping its readers in touch with the varied interests of institutions, A. C. S. sections, teachers' asssociations, and other organizations throughout the country. Items of general interest would include: (1) notices of local scholarships or fellowships; (2) notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.; (3) accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations (where original or unusual features are included it is desirable that they be described in some detail); (4) news notes concerning persons of sufficient prominence in their respective fields to make their movements of general interest; (5) promotions within, or changes of, personnel of a department; (6) announcements of new or unusual courses in chemical education or special fields of chemistry; (7) notes on new chemistry buildings or laboratories, stressing the unique features.

2. Providing an exchange column for positions. That is: (1) any teacher who is a subscriber to the JOURNAL, desiring to change his position, may advertise once a year without charge (correspondence will be handled through the editorial office, if desired); (2) any notices of vacancies, in which chemistry teachers and chemists will be interested, will also be published.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It would be desirable to have some person connected with each organization and institution appointed to report regularly.

Suitable material sent to the editorial office before the 20th of each month will be published in the following month's JOURNAL. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the above suggestions are followed, however, the necessity for such action will be largely obviated.

Mt. Holyoke College. Dr. Emma Perry Carr, professor of chemistry at Mount Holyoke College, has been awarded the Alice Freeman Palmer Memorial Fellowship of the American Association of University Women. Professor Carr will spend a year in Zurich, Switzerland, completing a monograph on absorption spectra in collaboration with Professor Victor Henri.

University of Maryland, College Park. Dr. Levin Bowland Broughton, who has been acting as head of the chemistry department of the University of Maryland, has been made permanent head of the department, it has been announced by President R. A. Pearson. His appointment has been approved by the Board of Regents. As head of the department he also is state chemist.

He is a native Marylander, having been born and raised at Pocomoke City. All his pre-college education, except one year at Bellfonte Academy, was obtained there.

Dr. Broughton, who received his B.S. degree at Maryland in 1908, his M.S. at the Old Line institution in 1911, and his Ph.D. at Ohio State in 1926, has been in the service of the University here ever since his graduation. During the interim between the receipt of his M.S. at Maryland and his Ph.D. from Ohio State, he took advanced work at George Washington and Johns Hopkins Universities.

In the course of his services at Maryland, Dr. Broughton in turn has been assistant professor of chemistry at the University, professor of agricultural chemistry, assistant chemist of the Maryland Experiment Station, and associate head of the department of chemistry.

Dr. Broughton is a member of the American Chemical Society, the Association of Agricultural Chemists, Phi Kappa Phi, Alpha Chi Sigma, and Sigma Xi.

He also has been recommended as associate referee on determinations for the Association of Official Agricultural Chemists (drug division).

Dr. Broughton is the author of a number of publications and papers, including the following:

Rate of diffusion types of lime in different types of soil; of different availability of different degrees of fineness of limestone for the neutralization of soil acidity; Relation of lime to agriculture, 1 and 2; Coefficient of digestibility of nut hulls and the utilization of same as a stock feed filler; Chemistry for pre-medical students; Basic ex-

change in two phases of a soil; Relation of fineness of grinding to the date of solution of limestone; and Field studies in relation to the efficiency of different degrees of fineness of limestone in correcting soil acidity.

He has made the following industrial studies for state industries: Vitamin Potency of Mayonnaise, Value of a By-Product Potash Residue for Crop Growth and Its Effect on the Constituents of Mixed Fertilizer.

Research work now in progress under his direction includes: quality protein, bio-chemical changes in pork as affected by curing, a study of methods for the determination of organic peroxides with special reference to the determination of ascaridole, and studies tending to improve the worm seed oil industry in the state.

Ralph Cornwell, formerly connected with the chemistry department of the University of Pittsburgh, has recently been appointed Senior Microanalyst at the U. S. Public Health Service, Hygienic Laboratory, Washington, D. C.

St. Louis University School of Medicine. Dr. Milton Levy who received the degree of Doctor of Philosophy in Biological Chemistry at the recent commencement exercises which closed the one hundred and eleventh year of St. Louis University, has been appointed a Fellow in Medicine by the National Research Council. Dr. Levy will work with Professor J. B. Conant at Harvard University.

Charles R. Henerey, B.S., St. Louis University, and Herbert S. Schmitt, B.S., St. Louis University, have been appointed graduate assistants in the department of chemistry and will work under the direction of Professor L. J. Wood or Professor J. P. Coony.

"Organic Syntheses." In order to facilitate the work involved in preparing the annual publication of "Organic Syntheses," the Editorial Board has been fortunate in securing the coöperation of Dr. C. F. H. Allen, of Tufts College, Mass., who is acting as Secretary to the Board. All correspondence regarding "Organic Syntheses" may be addressed to Dr. Allen, who will receive contributions to be considered for publication in future volumes.

High-School Chemistry Contest Sponsored by Oregon Section A. C. S. A five-man team of Columbia University High School in Portland won first place in the state second semester chemistry contest sponsored by the Oregon Section of the American Chemical Society, it was announced by the society's committee of awards. Honorable mention was given Seaside, Roseburg, Forest Grove, and Grant High School of Portland, in the order listed. Thirty-three high school teams from all sections of the state competed. These teams, consisting of a total of 152 members, represented 1300 students or 90% of the enrolment in second semester chemistry. The teams had from 3 to 12 members, according to the size of the class represented.

According to *The Sunday Oregonian*, the first prize trophy, a replica in metal of a liter graduated flask, fittingly engraved, becomes the property of Columbia University High. It was presented by a representative of the Oregon Section of the American Chemical Society at the commencement exercises of the school, Sunday, June 2nd. Members of the Columbia team, all Portland residents, were: Francis T. White, Andrew J. Schneider, David McLaughlin, John J. McCallig, and Wm. J. Laughlin. Fred J. Kohlruss is instructor.

Columbia University High School was founded by Archbishop Christie in 1901 and is conducted by the Congregation of the Holy Cross. Chemistry has been taught from the first and has been featured somewhat, according to Rev. Louis M. Kelley, president.

Seaside High School, which heads the honorable mention list, started its chemistry department this year. The

school has only ten students in the class, three of whom competed. The highest score of an individual member of any team was made by a member of the winning team, Columbia, and the second highest individual score by a member of Washington High School team of Portland. Since the contest was strictly by teams, the names of these individuals are not announced.

A copy of the examination questions is printed herewith for those interested in such a project for high-school chemistry classes.

OREGON HIGH SCHOOL PRIZE CONTEST FOR CHEMISTRY TEAMS, 1929

EXAMINATION QUESTIONS, MAY 10

Time: Not to exceed two hours.

Value of each part: One-third.

All answers to be the individual work of each student. All calculations to be shown.

PART I. A. STATEMENT. Some important chemical reactions are:

1. *Neutralization* of an acid and a base
   Solution of solids by addition of an acid to water-insoluble
2. Carbonate
3. Oxide
4. Metal
5. *Precipitation* of an insoluble substance by mixing two solutions
6. *Burning* a substance in air
7. *Decomposition* of a substance upon heating
8. *Reduction* of an oxide by heating with carbon
9. *Electrolysis* of a solution

QUESTION. Write one chemical equation to illustrate each of the above nine examples.

Write underneath each product its correct chemical name, and whether gas, solid or dissolved.

B. State the significance of the following terms, giving a clear illustration of each:

(1) Chemical symbol; (2) chemical formula; (3) chemical reaction; and perform numerical calculations ascertaining: (4) the percentage composition by elements of any pure substance you choose; (5) the weight of each substance involved in any chemical reaction you choose.

PART II. C. STATEMENT. Some of the chemical reactions of great economic importance are connected with the following manufacturers:

(1) Pig iron; (2) Portland cement; (3) sulfuric acid; (4) sodium hydroxide; (5) sodium carbonate.

QUESTION. Select any *one* of the above, and describe by the use of topical headings, outlines, and sketches.

D. How can an intelligent application of chemical principles be best applied to the improved preparation or use of EITHER FOODS OR FUELS?

PART III. E. STATEMENT. Certain well-known gases may be easily secured in the laboratory or cheaply by industrial processes. Among those are the following:

(1) Oxygen; (2) hydrogen; (3) nitrogen; (4) chlorine; (5) ammonia; (6) hydrogen sulfide; (7) sulfur dioxide; (8) acetylene; (9) carbon dioxide.

QUESTION. Write one chemical equation for the chemical reaction involved in either the small or large scale production of *each* gas.

Calculate the weight in grams of each material theoretically necessary to produce 22.4 liters, standard conditions, of any *one* of these gases.

F. Write briefly and selectively concerning laboratory experiments involving the following materials:

(1) Natural water; (2) soil; (3) milk; (4) complete identification of any three different pure chlorides.

ATOMIC WEIGHTS: Ba 137; Ca 40; C 12; Cl 35.5; Cu 64, H 1.0; Fe 56; Pb 207; Mg 24.3; Mn 55; Hg 201; N 14; O 16; K 39; Na 23; S 32; Zn 65.

The contest will be repeated next year and will probably become an annual event. The committee in charge consists of Professor John Fulton, Oregon State College, Corvallis; Professor O. F. Stafford, University of Oregon, Eugene, and Professor R. K. Strong, Reed College, Portland.

Carnegie Institute of Technology. A program of eight research studies in coal mining and metallurgy will be carried on during the year 1929-30, under the joint auspices of the United States Bureau of Mines, the Carnegie Institute of Technology, and Mining and Metallurgical Advisory Boards composed of mining and metallurgical engineers and executives, it is announced. Eight college graduates have been appointed to Research Fellowships to make the investigations.

The Research Fellows, while carrying out their investigations, will be candidates for the degree of Master of Science to be awarded by the Carnegie Institute of Technology in June, 1930. As in the

past, the reports of the studies will be published.

Appointees to Research Fellowships are Austin Gudmundsen, University of Utah; Bernard A. Jettner, College of Agriculture, Berlin, Germany; George C. Sprunk, Michigan State College; Donald A. Wallace, Iowa University; Boris N. Daniloff, Missouri School of Mines; John A. Heidish, Colgate University; Max W. Lightner, Pennsylvania State College; and Robert B. Meneilly, Grove City College.

Following is a list of studies selected:

Fuel Chemistry

1. A continuation of the Study of the Effect of Fusain and Related Inerts on the Properties of Pittsburgh Coal, with Particular Reference to Coking Properties.
2. A continuation of the Study of the Chemistry of Decay in Relation to Peat and Coal Formation.
3. A continuation of the Study of the Relation of Particle Size and Temperature to Rate of Burning.
4. A study of the Agglutinating Properties of Coal.

Ferrous Metallurgy

1. Methods of Determining Non-Metallic Inclusions
2. Viscosity of Open-Hearth Slags
3. A study of the Slag System MnO-Al_2O
4. A study of the Slag System MnO-Al_2O_3FeO

* * *

Appointment of Lawrence H. Schultz, of Fullerton, Calif., as assistant professor of chemistry in the Margaret Morrison Carnegie College has been announced at the Carnegie Institute of Technology. Schultz will fill a vacancy in the department of general science caused by the promotion of Dr. Charles Watkins, former professor and department head, who becomes chairman of the faculty of the Margaret Morrison Carnegie College.

Schultz received his A.B. degree at the University of Southern California in 1922, his M.A. degree at Columbia University in 1923, and his Ph.D. degree at Johns Hopkins this year. For four years he was assistant professor of chemistry at St. John's University, Shanghai, China.

Colgate University. According to *The New York Times*, the trustees of Colgate University recently accepted plans for a new chemistry building to be erected at a cost of $500,000 under the will of Miss Evelyn Colgate, whose bequest has been supplemented by a gift from her father, James C. Colgate. The building will be named in honor of Dr. Joseph MacGregory, who resigned this past June as head of the chemistry department after forty-four years of continuous service.

Dr. John Hemphill, associate professor of chemistry, resigned to go into industrial work.

An increase of $100 a year was voted for all members of the faculty. The limit for department heads was fixed at $5000.

Symposium on Chemical Kinetics, University of Minnesota. During the second term of the Summer Session, July 29–August 31, of 1929, a symposium will be devoted to the subject of chemical kinetics. Lectures will be given as a regular part of the Summer Session of the School of Chemistry by visiting lecturers and by members of the staff of Physical Chemistry. A joint seminar will be held once a week on special topics, the discussion of which will be led by the various lecturers in residence and by additional guests.

Professor Hugh S. Taylor, Princeton University, "Catalysis and Photochemistry."

Professor M. Polanyi, Kaiser Wilhelm Institute of Physical Chemistry and Electrochemistry, "Flow of Energy in Chemical Reactions."

Professor S. C. Lind, University of Minnesota, "Chemical Activation in Gaseous Ionization."

Assistant Professor R. S. Livingston, University of Minnesota, "Chemical Kinetics in Solution."

Washington University, St. Louis. The department of chemistry has been con-

ducting two courses in general inorganic chemistry, one in qualitative analysis, one in quantitative analysis and one in organic chemistry during the summer session. The Summer School in Chemistry is being directed by Professor L. McMaster. At the close of the Summer Session, Professor McMaster will spend some time in Colorado.

J. W. Neelly has resigned his assistantship in chemistry to enter commercial work.

Florence J. Gausmann, Edgar H. Bohle, Philip W. Schutz, Edward O. Haenni, and Frank T. Barr, graduates in chemistry and chemical engineering of last June, have been appointed assistants in chemistry.

Dr. Charles W. Rodewald, assistant professor of chemistry, sailed for France on June 19th for a stay of two months.

A. E. Goldstein, assistant professor of chemistry, and Mr. Charles A. Naylor, instructor in chemistry, are conducting some of the courses in the Summer School.

Mr. Al Steyermark has been appointed to a department of chemistry fellowship for the next academic year.

E. B. Kerone, a recent graduate in the department of chemical engineering, has been awarded a fellowship in the department for next year.

Helmut C. Gutekunst has been reappointed assistant in chemistry for next year. He will continue his work for the M.S. degree.

Jonas Carol, a graduate in chemical engineering, will be an industrial research fellow in chemistry and work for the M.S. degree this coming academic year.

Carl B. Benz, formerly assistant in the department of chemistry, is now chemist at the Monsanto Chemical Works.

Merle L. Griffin, formerly assistant in the department of chemistry, is now with the Roxana Petroleum Corp., at Wood River, Ill. He received the M.S. degree in June.

Dr. H. Lee Ward, of the department of physical chemistry, is spending the summer at Unadilla, N. Y.

Carbon Dioxide May Aid in Treating Pneumonia. A new method of treating pneumonia, using carbon dioxide inhalations may result from experiments recently reported to the National Academy of Sciences by Dr. Yandell Henderson of Yale University. Dr. Henderson and his associates, Prof. H. W. Haggard, G. L. Birnbaum, P. N. Coryllos, and E. M. Radloff, found the treatment valuable in a certain stage in experimental pneumonia. Inhalation of carbon dioxide has recently become widespread in the treatment of patients overcome by carbon monoxide gas poisoning.

In patients after surgical operations, the collapse of the lung is a stage or factor in the development of pneumonia, which sometimes complicates recovery after operations. Dr. Henderson and his colleagues found that the same collapse is a stage in the development of pneumonia experimentally produced in animals by introducing pneumonia germs into the lungs. Inhalation of carbon dioxide inflates the collapsed lung, thus preventing the development of pneumonia.

Dr. Henderson showed x-ray pictures of lungs that had been so collapsed. The pictures also showed the rapid inflation or redistention of the lung when the experimental animal had been put into a chamber containing 5 to 7 parts of carbon dioxide in 100 parts of air. The inhalation of the carbon dioxide induces deep breathing which redistends the lung.

Dr. Henderson emphasized that the results of his experiments are not to be interpreted as promising similar relief in the cases of pneumonia which the physician meets in his practice. But the discoveries that collapse is a stage in the development of the disease and that this treatment counteracts the collapse and reinflates the pneumonic lung indicates that here is a possible new means of controlling pneumonia, which is now a big cause of death.—*Science Service*

Recent Books

Photometric Chemical Analysis. (Colorimetry and Nephelometry.) Volume II. Nephelometry. JOHN H. YOE, Ph.D., Professor of Chemistry, University of Virginia, with contributions to Volume II by HANS KLEINMANN, M.D., Ph.D., Privatdozent, Chemical Department of the Pathological Institute, University of Berlin. John Wiley and Sons, Inc., New York City (also Chapman and Hall, Ltd., London), 1929. xvii + 337 pp. One photograph, two plates, and forty-four figures. 23 × 15 cm. $4.50.

The purpose and scope of this book is best stated by its author. "(1) To give an accurate account of the development of nephelometry; (2) to present an impartial discussion of the present status of the theory of nephelometry; (3) to give detailed working directions for using a precision nephelometer; (4) to discuss nephelometric research; (5) to give procedures for the determination of a number of inorganic and organic constituents, and (6) to give an accurate and fairly complete survey of the literature on nephelometry." It is the reviewer's opinion that Dr. Yoe has accomplished his purpose in excellent fashion.

The book is divided into five parts. *Part I* deals with the theory, instruments, methods, history, etc., of nephelometry. *Part II* deals with Inorganic Nephelometry. The chapter headings are Ammonia, Arsenic, Calcium, Chlorine, Phosphorus, Sulfur. *Part III* deals with Organic Nephelometry. Analyses for acetone, amylase, mustard gas, fats and oils, lipase, nucleic acids, β-oxybutyric acid, pepsin, proteins, purine bases, and trypsin are included. *Part IV* is a comprehensive bibliography. *Part V* comprises useful tables such as analyses of glassware, data on the strengths of common acids and ammonia, solubility of several gases in water, conversion table of liquid capacity units, atomic weights, and logarithms.

Every analysis is fully described and discussed, with especial attention to errors, etc. The original literature references are furnished with each procedure. The book is abundantly interleaved with cross-section paper, there being a page or so for every procedure. Thus the data for a given analysis may be plotted where they will be most useful. Of added interest are the photograph of T. W. Richards and facsimile letters written by him to Dr. Kober. A page of errata in Volume I is also included.

Nephelometry is a worthy companion volume to Colorimetry. The reviewer is pleased to congratulate Dr. Yoe on this very useful and painstaking piece of work. Any teacher of advanced quantitative analysis, or any one engaged in work calling for nephelometric estimation, should certainly have a copy of this book.

MALCOLM M. HARING

UNIVERSITY OF MARYLAND,
COLLEGE PARK, MD.

The Medical Aspects of Chemical Warfare. EDWARD B. VEDDER, Lieut. Colonel, M.C., U. S. A. With a Chapter on the Naval Medical Aspects of Chemical Warfare, by DUNCAN C. WALTON, Lieut. Commander, M.C., U. S. N. Williams and Wilkins Co., Baltimore, Md., 1925. xvi + 327 pp. 54 illustrations. 15.5 × 23.0 cm. $6.50.

The primary purpose of the book is to present practical information about chemical warfare to the medical officers in our military service. The book is so written, however, that it should be of interest and value to others who are interested in national defense.

The first chapter gives a brief history of the development of chemical warfare.

The next four chapters deal with the fundamental principles of physics, chemistry, and meteorology which are particularly related to the use of war gases. A classification of the different chemical warfare agents is followed by five chapters in which the specific physiological effects of the different gases are discussed. Among the gases included are the following: chlorine, phosgene, chlorpicrin, mustard, lewisite, chloracetophenone, brombenzylcyanide, diphenylchlorarsine, diphenylaminechlorarsine. The different methods of protecting individuals and armies against gas are outlined in considerable detail. The general plan of organization of the medical department for field treatment and transportation of gassed cases is given. A chapter is devoted to the presentation and discussion of statistics showing the ultimate results of gas poisoning.

Very few typographical errors were noticed. There is need of revision in one paragraph, on page 27, in which it is stated that although alcohols can be prepared synthetically, in practice methyl alcohol is obtained from the dry distillation of wood.

The book fulfils its primary purpose admirably, and because of its simple, straightforward presentation it should be of interest to others than those in the military service. It points out in a convincing manner that gas warfare is not more brutal or inhumane than other forms of warfare, and that since it is more efficient, it will probably survive as an instrument of warfare. The book is not intended to be a text; it is a reference work, and as such it should be of value to students of chemistry, as well as to those studying medicine or military science.

E. ROGER WASHBURN

UNIVERSITY OF NEBRASKA,
LINCOLN, NEBRASKA

John Wesley among the Scientists. FRANK W. COLLIER, Professor of Philosophy, American University. The Abingdon Press, New York City. 351 pp. 2 illustrations. 12.8 × 18.8 cm. $2.00.

This book opens with the portrayal of the charm physical science had for John Wesley and his conception and survey of this field. It next reveals Wesley as possessing such scientific spirit, methods, and ideas as would further promote science, were the time thoroughly imbued with his viewpoints on these three basic things. With all of this as a background the author clearly shows the philosophy of Wesley in placing religion and science in the same channel, the source of which is a Supreme Authority, and in which religion and science may flow together with mutual enrichment.

The book is rich in citations and deductions by the author to prove that John Wesley, a religionist whom Lecky says, "worked an epoch in English history," held that physical science was a factor in the proper kind of a cultural basis for his religious ministry and that he was a promoter of physical science on an experimental basis. Wesley is quoted as saying, "Chemistry is what has given the modernists the great advantage they have over the ancients."

Dr. Edwin S. Slosson states in the foreword of this book under the caption, "An Appreciation," that the author "has done a service to historic truth and personal justice in proving that John Wesley was well abreast of the science of his day and showed greater interest in the study of science in its various branches than is common among the preachers of our time and that he showed greater appreciation of its cultural and religious value than is common among scientists."

LOUIS W. MATTERN

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Incentives to Study; a Survey of Student Opinion. ALBERT BEECHER CRAWFORD. New Haven: Yale University Press, 1929. (Published on the Louis Stern Memorial Fund.) xii + 194 pp. 21.5 × 28 cm. $5.00.

Mr. Crawford is the Director of the Department of Personnel Study and

Bureau of Appointments at Yale University. This book presents his doctorate thesis. The purpose of the investigation was to analyze the factors underlying academic success, with particular reference to the factors underlying the motivation of Yale undergraduates. Use is made at the outset of a survey conducted in 1926 by the students themselves and advantage was taken of the unusual amount of interest manifested by the students in the course of study at Yale as exhibited in a report made on this topic by a committee of the Student Council of Yale College.

The general plan of Mr. Crawford's study was to compare groups of students differing in certain respects but alike as possible in other respects, and to look for corresponding differences, if any, in their academic records. The chief factors selected for this scrutiny were (1) differences in intrinsic potential mental ability (measured by the Anderson Examination or the Scholastic Aptitude Test) and (2) differences in external conditions, of which were studied (*a*) family income, (*b*) own expenses, (*c*) degree of self-support, (*d*) family occupation, (*e*) family education, (*f*) family influence, (*g*) reasons for entering college, (*h*) "degree of orientation"—meaning purpose in life, and (*i*) intended occupation. Physique and health were not considered, nor age at entrance. It was assumed that the college marks were sufficiently reliable for the large-group comparisons undertaken.

The following are among the conclusions reached:

1. Potential mental ability is the foremost factor underlying college success.

2. Students working their way through college are superior in classroom achievement to those not self-supporting.

3. Students spending the least money attain distinctly high records (partly due to the seriousness of purpose attendant upon sacrifice and effort).

4. The average college grade varies inversely with family income.

5. Students handicapped financially spend more time in study and achieve higher average grades than students favored financially.

6. The sons of professional fathers (teachers, lawyers, doctors, ministers) are distinctly superior in potential ability and in college standing to the sons of fathers engaged in business and other occupations.

7. To be motivated by a purpose in life, especially by a definite occupational purpose, like preparing for a profession, is a factor of measurable advantage in achieving academic success.

8. Academic performance appears not to be sensibly affected by (*a*) family education, (*b*) family tradition as to career, or (*c*) position awaiting on graduation.

9. At Yale, students engaged in various extracurricular activities are slightly superior in potential ability and superior in classroom grades to students not so engaged. The poorest students of all are those neither engaged in such activities nor working for self-support; "they toil not, neither do they spin."

10. The various eligibility requirements set up for participation in sports and other campus activities furnish a very effective motivation to a certain group of students; this secondary (or even negative) influence affords more spur to many able students than does any positive urge inherent in the college curriculum itself. The much-abused extracurricular activities are "one of the few stimuli to academic effort still extant."

11. A different attitude is found in the liberal arts college from that in the Sheffield Scientific School with respect to prescribed and elective courses, the relative merits of different subjects, and similar matters.

12. Mere exposure to a college subject taken unwillingly "is not likely to prove educationally stimulating or beneficial." The value of any subject is not inherent in the subject regardless of the student's attitude toward it, but is proportionate to the student's effort and interest in it. Failure to capitalize the "inherent value of purpose so interpreted that the student

can appreciate it" is one reason why subjects that are required secure from students less valuable and effective work than subjects they have elected.

13. Freshmen counseling is of major importance if so carried on as to further the right intellectual attitude in the entering student.

Many of these conclusions of Mr. Crawford are familiar to those who have followed similar studies in our schools and colleges, and many of his recommendations, similarly, have been made before (for example, in Richardson's *Study of the Liberal College*, Hanover, **1924**). However, that does not detract from the author's presentation; it is worthwhile to have these confirmations from Yale, and it will need more than one such interesting and stimulating discussion to evoke any awareness at all of the inadequacies and absurdities of the liberal college of today on the part of the hide-bound reactionaries too often in control of the destiny of higher education in America.

It would be interesting to know to what extent the picture drawn by Mr. Crawford differs from what might have been drawn on the basis of a similar study a generation ago. It would also have been interesting (and this Mr. Crawford might have done) to have compared this picture of college success with similar pictures that have been drawn recently of the conditions underlying scholastic success in the public school.

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The American Chemical Industry. Department of Commerce. Trade Promotion Series, No. 78. U. S. Govt. Printing Office, Washington, D. C., 1929. 114 pages. 23 × 15 cm. $0.20.

This report is a summary of the production and foreign trade of the American chemical industry during the first quarter of the 20th century. It contains numerous charts, graphs, and tables showing the growth of the various chemical industries. The information presented in this publication should be of value to students of both economics and of chemistry; to the former it will furnish a perspective of the chemical industry and to the latter an economic interpretation of our chemical science and industry which has made such vast strides during the past twenty-five years.

M. W. G.

Blue Book of Southern Progress. Manufacturers Record, Baltimore, Md., 1929. 324 pp. 23 × 15 cm. $0.50.

The purpose and scope of this publication is ably stated in the foreword:

"The Blue Book of Southern Progress has become the recognized authority of the entire country on the resources and the progress of this section. It is not merely a handbook of statistical information, invaluable as these statistics are, but it is a running story or commentary on the progress of the South and of the wide range and variety of the resources of this section.

"Into the annual editions of the Blue Book of Southern Progress are condensed facts gained from a study of the South during the nearly fifty years in which the *Manufacturers Record* has been published. Many phases of southern life are covered somewhat differently in each issue, and thus annual volumes become of increasing value from year to year, containing as they do information which can be found nowhere else about the South and its achievements." M. W. G.

Dow Chemicals. THE DOW CHEMICAL COMPANY, Midland, Michigan. 102 pp. Colored and half-tone illustrations. 26 × 19 cm.

This attractively bound catalog contains information concerning properties, physical constants, uses, etc., of over 130 chemical products including pharmaceutical and industrial chemicals, dyes, and insecticides.

Spectroscopy in Control of Purity in Food Stuffs. ADAM HILGER, LTD., London, England. March, 1929. 7 pp. 24.5 × 15.5 cm.

The subject is considered in four divisions:

(*a*) Emission spectrography as applied to the examination of inorganic materials.

(*b*) Emission spectrography as applied to the examination of organic materials.

(*c*) Absorption spectra of organic materials in the visible region.

(*d*) Absorption spectra of organic materials in the ultra-violet region.

Bulletin of Spectrum Analysis. No. 1. March, 1929. Adam Hilger, Ltd., London, England. 12 pp. 24.5 × 15.5 cm.

Youth and the True. School Betterment Studies. Vol. 1, No. 3. Henry C. Frick, Educational Commission, Pittsburgh, Pa., 1929. 47 pp. 12.5 × 18 cm. Free.

This publication completes the program outlined by the Henry C. Frick Educational Commission. (See THIS JOURNAL, **6**, 819, April, 1929.)

Report of the National Research Council for the Year July 1, 1927, to June 30, 1928. U. S. Govt. Printing Office, Washington, D. C., 1929. 95 pp. 23 × 15 cm.

Self-Help for College Students. WALTER J. GREENLEAF, Assoc. Specialist in Higher Education, Bureau of Education. *Department of the Interior*, No. 2, 1929. U. S. Govt. Printing Office, Washington, D. C. 136 pp. 23 × 15 cm. $0.25.

The information assembled in this publication will be valuable to prospective students who wish to know of the possibilities of self-help in various institutions.

The table of contents indicates the scope of material:

Part I—Going to College
- Transition from high school to college
- Financial aspects
- Student loan funds

Part II—Self-Help
- Choice of what to do
- Finding the job
- Earning one's way through college

Part III—Institutions of higher learning
- A directory by states

Accredited Secondary Schools in the United States. Prepared in the Division of Statistics, FRANK M. PHILLIPS, Chief. *Department of the Interior, Bureau of Education, Bulletin*, 1928, No. 26. U. S. Govt. Printing Office, Washington, D. C., 1929. 144 pp. 23 × 15 cm. $0.20.

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- Association of Colleges and Secondary Schools of the Middle States and Maryland
- New England College Entrance Certificate Board
- North Central Association of Colleges and Secondary Schools
- Northwest Association of Secondary and Higher Schools

Publications of the U. S. Bureau of Education of Special Interest to High-School Teachers. *Department of the Interior*, Bureau of Education, Washington, D. C., 1929. 7 pp. 23 × 15 cm. Free.

Per Capita Costs in Teacher-Training Institutions, 1927-28. FRANK M. PHILLIPS, Chief, Division of Statistics. *Department of the Interior, Bureau of Education*. U. S. Govt. Printing Office, Washington, D. C., 1929. 6 pp. 23 × 15 cm. $0.05.

BOOKS RECEIVED—LIBRARY OF CONGRESS, MAY 15 TO JUNE 22, 1929

Bailey, Dorothy, and Kenneth C. Bailey, An etymological dictionary of chemistry and mineralogy. London, E. Arnold & Co., 1929. viii, 307, 1 p. 22½ cm.

Bauer, Hugo, Chemische technologie der fette und öle. Berlin, P. Parey, 1928. xv, 423 pp., illus. 24 cm.

Bell, James Munsie, and Paul M. Gross, Elements of physical chemistry. New York, Longmans, Green and Co., 1929. xiii, 466 pp., illus., diagrs. 21 cm.

Cameron, Alexander Thomas, A textbook of biochemistry for students of medicine and science. 2 plates and 12 text figures. London, J. & A. Churchill, 1928. x, 462 pp. incl. illus., tables, diagrs. II pl. 21 cm.

Caven, Robert Martin, and J. A. Cranston, Symbols and formulas in chemistry; an historical study. London and Glasgow, Blackie & Son, Limited, 1928. ix, 220 pp. front. (facsim.) illus., diagrs. 22½ cm.

Desbleds, L. Blin, Exact colour matching and specifying. Paris, Technological and Industrial Service, 1928. 2 pp. l., 7–116 pp., pl., diagrs. 21 cm.

Euler-Chelpin, Hans Karl August Simon von, Chemie der enzyme. München, J. F. Bergmann, 1927. v. diagrs. 26 cm.

Foote, Perry Albert, Derivatives of para-methoxycinnamic acid. Baltimore, 1928. Cover-title, pp. 958–962. 26 cm. Thesis (PH.D.)—University of Wisconsin, 1928.

Fürth, Arthur, Die werkstoffe für den bau chemischer apparate, 72 abbildungen im text und auf 2 tafeln und 37 tabellen. Leipzig, O. Spamer, 1928. viii, 220 pp. incl. illus., tables, diagrs. II pl. 24 cm.

Gascoyne, William John, Jr., Comp., Chemical terms used on fertilizer materials, feeding stuffs, fats, and oils explained. Rev. ed. Baltimore, Md., Gascoyne & Company, Inc., 1929. 2 pp., 1 l., 7–57 pp. incl. front., tables. 21 cm. $0.50.

Gura, Isaac Jacob, De principio plantarum acri. Halae, litteris Franckianis, 1791. 3 pp. l., 66 pp. 21 × 10½ cm. Diss.—Halle.

Heaton, Noel, Outlines of paint technology; based on Hurst's "Painters' colours, oils, and varnishes." 6 plates and 109 illustrations. London, C. Griffin & Company, Limited, 1928. x, 400 pp. front., illus., vi pl., fold. tab., diagrs. 23 cm.

Holmyard, Eric John, The great chemists. London, Methuen & Co., Ltd., 1928. vi, 137 pp., 1 p., front. 17½ cm.

Hurd, Charles Dewitt, The pyrolysis of carbon compounds. New York, The Chemical Catalog Company, Inc., 1929. 8 p., 1 l., 9–807 pp. 23½ cm. (American Chemical Society. Monograph series. No. 50.)

Kharasch, Morris Selig, Heats of combustion of organic compounds. (RP 41, in U. S. Bureau of Standards. Bureau of Standards *Journal of Research*. Washington, U. S. Govt. Print. Off., 1929. 23½ cm. February, 1929. v. 2, no. 2, pp. 359–430 incl. tables.)

Krische, Paul, Die untersuchung und begutachtung von düngemitteln, futtermitteln, saatwaren und bodenproben nach den offiziellen methoden des Verbandes landwirtschaftlicher versuchs-stationen im Deutschen Reiche. Berlin, P. Parey, 1929. xxii, 385, 1 p. 24 cm.

Merck, Klemens, Klemens Merck's warenlexikon für handel, industrie, und gewerbe. Beschreibung der im handel vorkommenden naturund kunsterzeugnisse, unter besonderer berücksichtigung der chemisch-technischen und anderer fabrikate, der drogen- und farbwaren, der kolonialwaren, der landesprodukte, der material- und mineralwaren. Leipzig, G. A. Gloeckner, 1890. viii, 722 pp. 24½ cm.

Michalek, John Clarke, The vapor pressure and vapor density of dry ammonium chloride. Urbana, Ill., 1928. 11 pp. 23 cm. Abstract of thesis (PH.D.)—University of Illinois, 1927.

Murray, Harry Athol, A physico-chemical study of gum arabic. New York

City, 1928. 24 pp., diagrs. 23 cm. Thesis (PH.D.)—Columbia University, 1928.

Neal, Raymond Elwood, Short laboratory course in general chemistry. New York, The Macmillan Company, 1929. viii pp., 2 l., 106 pp., illus. 19½ cm.

Odell, William Wallace, Carburetion of combustible gas with butane and propane-butane mixtures with particular reference to the carburetion of water gas. Washington, U. S. Govt. Print. Off., 1929. vi, 96 pp. incl. illus., tables, diagrs., 2 pl. (1 fold.). 24½ cm.

Richeter, Victor von, Richter-Anschütz Chemie der kohlenstoffverbindungen; oder, Organische chemie. Leipzig, Akademische verlagsgesellschaft m. b. h., 1928. v. illus., diagrs. 24 cm.

Schilt, Werner, Beiträge zur asymmetrischen synthese. Gebr. Leemann & Co., 1920. 112 pp., 1 l. 23 cm.

Schmitt, Georg Friedrich, Zur kenntnis der formylcellulosen. J. Lang's Buchdruckerei, 1927. 4 p. l., (6)—65 pp. incl. pl., diagrs. 22 cm.

Sohlman, Ragnar, and Henrik Schuck, Nobel, dynamite and peace. Translated by Brian and Beatrix Lunn. New York, Cosmopolitan Book Corporation, 1929. 5 p. l., 353 pp. front., plates, ports. 24½ cm.

Stroumza, Jacques, De la thérapeutique colloidale en pathologie comparée et de l'utilisation d'un complexe colloidal or et argent. Paris, Vigot Frères, 1926. 78 pp., 1 l., diagrs. 24 cm. Thèse—Univ. de Paris.

Swift, Anna Hazel, The American chemical industry. Production and foreign trade in first quarter of twentieth century. Washington, U. S. Govt. Print. Off., 1929. vi, 114 pp. incl. tables, diagrs. 24½ cm.

Timmermans, Jean, La notion d'espèce en chimie. Paris, Gauthier-Villars, 1928. 2 pp., l., 134 pp., diagrs. 22 cm.

Ubbelohde, Leo, ed., Ubbelohde's handbuch der chemie und technologie der öle und fette; chemie, vorkommen, gewinnung und verarbeitung der öle, fette, wachse und harze. Leipzig, S. Hirzel, 1929. v. illus., fold. plates, diagrs. 25½ cm.

Wertheim, Edgar, A manual of elementary organic chemistry. Ann Arbor, Mich., Edwards Brothers, 1929. 1 p. l., iii, 486 pp., diagrs. 27 cm.

Wolff, Hans, Die natürlichen harze Stuttgart, Wissenschaftliche verlagsgesellschaft m. b. h., 1928. xvi, 379 pp. incl. illus., tables. 24½ cm.

Gt. Brit., Dept. of scientific and industrial research. Gas cylinders research committee. Third report of the Gas cylinders research committee (alloy steel light cylinders). London, H. M. Stationery Off. printed by Harrison and Sons, Ltd., 1929. iii, 74 pp., 1 l. incl. illus., tables, diagrs., plates. 24½ cm.

Gt. Brit., Dept. of scientific and industrial research. Gas cylinders research committee. Fourth report of the Gas cylinders research committee (cylinders for liquefiable gases). London, H. M. Stationery Off. printed by Harrison and Sons, Ltd., 1929. v. 151 pp. illus., tables (part fold.), diagrs. 24½ cm.

New aid in chemistry for reviews and tests. New York City, Regents Publishing Co., Inc., 1929. 4 pp. l., 50, 34 p., illus. 17 cm.

Regional Plan of New York and Its Environs, Chemical, metal, wood, tobacco, and printing industries, present trends and probable future developments. New York, 1928. 226 pp. incl. tables, fold. maps, diagrs. 28 cm.

U. S. Civil-Service Commission. Opportunities for chemists in the United States Civil Service. Washington, U. S. Govt. Print. Off., 1929. iii, 28 pp. 24½ × 9½ cm.